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ABSTRACT

This packet contains six units of informational materials and transparency masters, with accompanying scripts, for teachers to use in a plant science course in vocational agriculture. Designed especially for use in Texas, the first unit introduces the course through the following topics: economic importance of major crops, major areas of production, and major uses of crops. The second unit covers plant growth, including plant parts and their functions, seed germination, and how plants make, use, and store food. The third unit covers classification and selection of field crop plants, while unit 4 covers sexual and asexual plant reproduction. The fifth unit discusses seedbed preparation, including the following four topics: disposing of previous residue, land preparation, application of fertilizer, and irrigation. The final unit on planting covers selection of seed and equipment and methods in planting. Each topic section of the units contains information sheets, scripts for transparencies, references, and transparency masters. (KC)

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ED235337

PLANT SCIENCE

IV-A-1 to IV-F-2

BASIC V.A. I

1980

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PLANT SCIENCE

Unit A: Introduction

Topic 1: Economic Importance of Major Crops to the County, State, and Nation

1. Importance of Plants

a. Plants furnish most of the necessities of life for man either directly or indirectly. If plant life suddenly disappeared from this plant-oriented globe, man and animal would also disappear. Plants furnish the following necessities on this earth:

Oxygen for man and animal to breathe
Fuel for heating and transportation
Building materials
Medicines and drugs
Food for man and animal nutrition
Fabrics for clothing and other purposes
Plastics
Paper
Cover against water and wind
Erosion
Cover for recreation and sports facilities
Habitat for plants and animals
Landscape beautification

b. The two most important achievements of man since prehistoric times have been the domestication and selection of plant species.

2. History of Crop Production

a. Crop husbandry began about 10,000 years ago when man planted his first seed in the soil and domesticated his first animal. Before man domesticated plants and animals he had little control over a continuous and adequate supply of food and clothing. He existed as a nomadic hunter who gathered food and fiber by searching for it as he wandered over the earth.

b. About 10,000 years ago hand-labor cultivation began in the middle East. The early agriculturist had to draw upon wild plants and animals in order to develop major food plants and major animal breeds that are prevalent today. Agriculture spread from the middle East to the western and northern shores of the Black

Sea and then to the Valley of the Indies in eastern India and to northern China. The growth and development of early agriculture in the Western Hemisphere has been considered independent of agriculture and development in the eastern part of the world.

c. First crops of importance:

Two varieties of wheat and barley were discovered in Iraq that indicated it had been grown seven thousand years ago. Both wheat and barley were developed in southwestern Asia. Wheat was first grown in Massachusetts in 1602.

Fossilized corn pollen said to be 60,000 years old has been discovered below Mexico City. Small corn cobs thought to be 6,000 years old were found in a cave in New Mexico. Corn and potatoes were among the major cultivated plants discovered in the New World.

Rice was used extensively as a cereal in China by 2800 B.C. There are several wild species of it in southeast Asia; it is thought to have been developed in Asia. Rice was successfully grown in the New World for the first time in 1685, in the Carolinas.

Cotton, the king of fibers, was developed before the first century. In 1929, cotton fibers that dated back to 3000 B.C. were found in Pakistan. Cotton was grown in India about 5,000 years ago. When Columbus discovered the New World (1492) he found both cotton and tobacco being used by the natives.

Sorghums originated as a cultivated plant in Africa thousands of years ago. Grain sorghum was developed in Africa, China, and India as a human food, It was developed in the United States mainly as a feed for livestock and poultry.

Crop production was considered a highly developed art at the time it appeared in Egyptian, Greek, and Roman writings.

d. The people from the Old World (Europe) brought many of their agricultural practices and skills to the New World (North America). Even though many of the crops were different from those found in Europe, similar farming practices were used to grow corn, tobacco, rice, and cotton.

Approximately 90 percent of the colonists were engaged in farming as late as 1800. Tobacco, rice, and cotton were the major export crops produced by the colonies. The invention of the cotton gin in 1793 and the invention of the mechanical reaper in 1831 increased the possibilities of exporting cotton and producing more grain crops at home.

Transparency No. 1

3. Crop Land Area and Use

a. Only 7.7 percent of the earth's surface is adaptable to cultivation, and 70 percent of this area (1.6 billion acres) is in grain crops.

All the food and fiber crops in the United States (50 states) is produced on about 1,837,000,000 acres of land. The total land area in the fifty states is 2,271,000,000 acres.

b. United States land usage for agriculture is as follows:

Crop land - 458,000,000 acres cultivated
Pasture - 633,000,000 acres
Forest - 746,000,000 acres

Agricultural land lost each year to recreation and other usage:

Urban development - 420,000 acres
Lakes - 420,000 acres
Airports and Roads - 160,000 acres

c. Harvested land area and use in Texas:

In 1972, there were 17,048,100 total crop acres harvested. An additional 247,000 acres devoted to vegetable production was also harvested. There are 145 million acres in farms. The state consists of 168,217,600 acres of land area and 2,879,300 acres of inland water. Approximately 10 percent of the total land area in the state is used to produce the major crops.

4. Importance of United State Agriculture

a. No country in the world can compete with the United States in the quantity and quality of foods produced from plants. At the turn of the century one farmer was producing enough food for himself and five other people. Today one U. S. farm can produce enough food for about fifty people. Millions of tons of grain and fiber are exported each year from the U. S. to countries that are unable to produce enough agricultural products to meet the needs of the people.

b. The reasons that the U. S. is producing an abundance of crop products are: education in agriculture, adequate capital, continuous research, abundance of arable soil, proper use of technology, and an adequate labor force.

References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.

2. Janick, Jules and others, Plant Science: An Introduction to World Crops, W. H. Freeman and Company, San Francisco, CA, 1969.

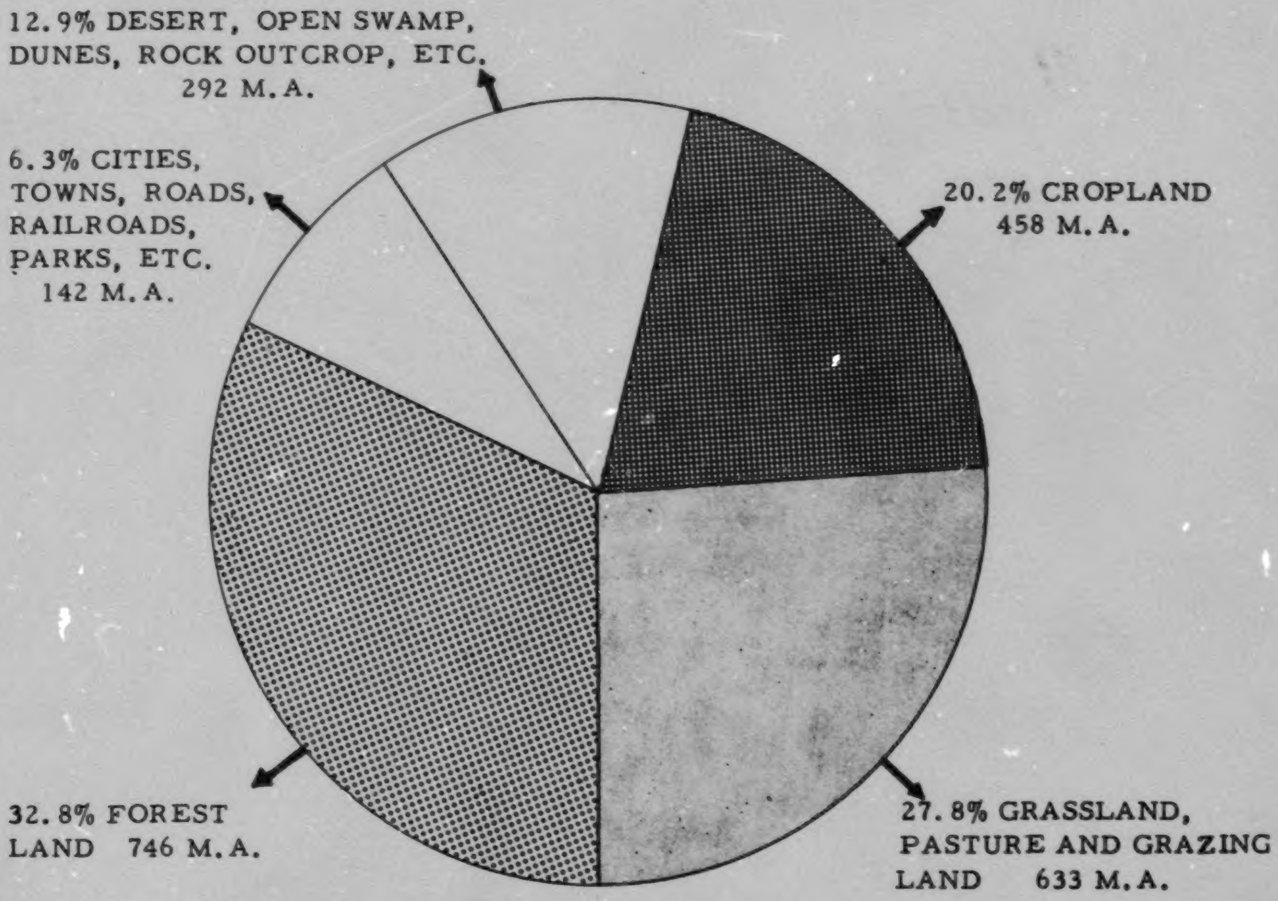
3. The Fertilizer Handbook, The Fertilizer Institute, Washington, D.C., 1972.

4. Texas Almanac, Dallas, TX, 1973.

MAJOR USES OF LAND

TOTAL U.S. ACREAGE

2,271 MILLION ACRES (50 STATES)



M.A. - MILLION ACRES

Vocational Instructional Services
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IV-A-2
Basic V. A. I
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PLANT SCIENCE

Unit A: Introduction

Topic 2: The Major Areas of Production -- State, Nation, and World.

Suggested Procedure and Activities: Transparencies can be made from the topic maps and statistical information. Refer to maps to locate areas and refer to tables for major crops.

1. The Major Factors That Restrict Crop Areas

The four major factors that restrict crop areas are: climate, soil, economic factors, and available water supply.

a. Climatic conditions consist of rainfall, length of growing season, temperature, wind velocity, humidity, sunlight, and day length.

Crops differ in their capacity to grow and produce under various climatic conditions.

Cotton, rice, sorghum, corn, cowpeas, and certain vegetables do better in warm climates.

Wheat, potatoes, sugar beets, and many cereals (except corn) do better in cool climates.

Flax, spring oats, wheat, and barley are adaptable to semi-arid regions of the world. They are found in moderately dry areas in North America, Europe, and Asia.

b. Soils differ in type, thickness of different layers, texture, color, and compactness. Much of the land is not suited for crops due to the following reasons:

Low fertility
Poor drainage
Rocky and rough surface
Improper soil type
Too hilly for cultivation

c. Economic factors that affect the type of crop grown in the different areas of any country are:

Land value
Labor requirements
Transportation
Demand for certain type of crops
Shortage of either seed, fuel, labor, and/or fertilizer

Land with a high value requires a high unit value crop. Hand labor is still needed in certain crop areas. Fruits and vegetables are generally harvested by hand labor. Transportation cost is a factor that may determine a crop enterprise. The method of transportation is not a limiting factor in crop production. Certain areas of the population demand a specific type of crop. It is necessary that parts of the world grow rice because people demand rice as a basic food.

d. Available water supply is considered in the form of both underground and surface water. Dams on rivers and smaller streams are constructed for two purposes: water to be used for fertile land irrigation and water for human consumption. Underground water is not always available for all fertile land areas. Although approximately 36,978,000 acres are under irrigation in the United States, irrigation practices in underdeveloped countries is inadequate to meet the needs of desirable crop production standards.

Transparency No. 1 and Table 1

2. The Crop Districts of Texas and the Major Crops Produced in Those Districts

   a. Northern High Plains - Sorghum, wheat, hay, soybeans, cotton, vegetables, and barley

   b. Southern High Plains - Cotton, sorghum, hay, vegetables, and soybeans

   c. Northern Low Plains - Wheat, barley, oats, hay, alfalfa, and guar

   d. Southern Low Plains - Cotton, sorghum, wheat, oats, and hay

   e. Cross Timbers - Oats, peanuts, hay, and wheat

   f. Blacklands - Cotton, sorghum, wheat, barley, oats, corn, peanuts, vetch, hay, and soybeans.

   g. East Texas - Corn, oats, peanuts, hay, soybeans, vetch, vegetables, and fruit

   h. Trans-Pecos - Cotton, sorghum, barley, and hay

   i. Edwards Plateau - Sorghum, oats, peanuts, and hay

   j. Southern Central - Corn, sorghum, rice, cotton, flax, vegetables, and hay

k. Coastal Bend - Cotton, sorghum, flax, and hay

l. Upper Coast - Rice, sorghum, cotton, corn, vegetables, hay, and soybeans

m. South Texas - Sorghum, peanuts, vegetables, flax, and citrus

n. Lower Valley - Cotton, sorghum, corn, hay, vegetables, and citrus

Transparency No. 2 and Table 2

3. The National Crop Areas and Major Crops Found Within Each Area

a. Grazing and Irrigated Crop Region - Sugar beets, wheat, sorghum, Irish potatoes, hay (clover, timothy, alfalfa), cotton, and vegetables

b. Corn Belt - Corn, wheat, oats, hay (clover, timothy, and alfalfa), soybeans, and barley

c. Cotton Belt - Cotton, corn, sorghum, peanuts, tobacco, sugarcane, soybeans, cow peas, hay, and vegetables

d. Corn and Winter Wheat Belt - Corn, winter wheat, hay (clover, timothy, and alfalfa), soybeans, and oats

e. Hay and Dairy Region - Hay (clover, timothy, and alfalfa), corn, wheat, oats, and Irish potatoes, and barley

f. Forest and Hay Region - Hay (clover, timothy, and alfalfa), wheat, and Irish potatoes

g. Spring Wheat Region - Spring Wheat, oats, hay (clover, timothy, and alfalfa), Irish potatoes, and corn

h. Hard Winter Wheat Region - Wheat, sorghum, alfalfa, barley, and oats

i. North Pacific Hay and Pasture Region - Wheat, oats, hay (clover, timothy, and alfalfa), and sugar beets

j. Pacific Subtropical Crop Region - Vegetables, fruits, rice, sorghums, alfalfa hay, Irish potatoes, and cotton

k. Humid Subtropical Crop Belt - Rice, corn, sorghum, hay, vegetables, fruits, and sugarcane

4. The Crop Production Areas of the World and the Major Crops Produced in Each Area

Transparency No. 3

a. United States and Canada - The U. S. and Canada possess 22.7 percent of the world's cultivated land. The two countries rank first in wheat, corn, oats, hay, and tobacco production. The United States leads in cotton, corn, fruit, and vegetable production.

b. South America (Brazil and Argentine) - These two countries produce rice, coffee, sugarcane, cacao, cotton, beans, potatoes, tobacco, and barley.

c. Europe (Western and Central) - Europe produces hay crops, wheat, oats, barley, sugar beets, corn, and flax.

d. Russia - Russia has less than 10 percent of the five and one-half billion acres in cultivation. The chief crops in the central region are flax, wheat, rye, oats, and barley. Southwest Russia produces wheat, barley, oats, rye, flax, and potatoes.

e. South Africa - South Africa produces mostly cereals. The principal cereal crops are: grain sorghum, corn, wheat, oats, barley, and rye. Other major crops grown in the country are: cotton, sugarcane, and hay.

f. India and China - India, like China, produces rice and other cereal crops. Grain sorghum and millets are produced as human food. Other crops of importance in India are corn, barley, and wheat.

h. North Africa - North Africa produces cereal crops in the irrigated regions. Cotton and oil producing plants are considered important in Egypt, Algeria, and Morocco.

References:

1. Delorit, Richard J., and Henry L. Ahlgren, Crop Production, Prentice-Hall, Ind., Englewood Cliffs, NJ, 1967.

2. Hughes, Harold D. and others, Crop Production Principles and Practices, The Macmillan Company, NY, 1967.

3. Texas Field Crop Statistics, Austin, TX, 1972.

4. Texas Vegetable Statistics, Austin, TX, 1972.

MAJOR CROPS PRODUCED IN TEXAS
Statistical Information - 1972
Table 1

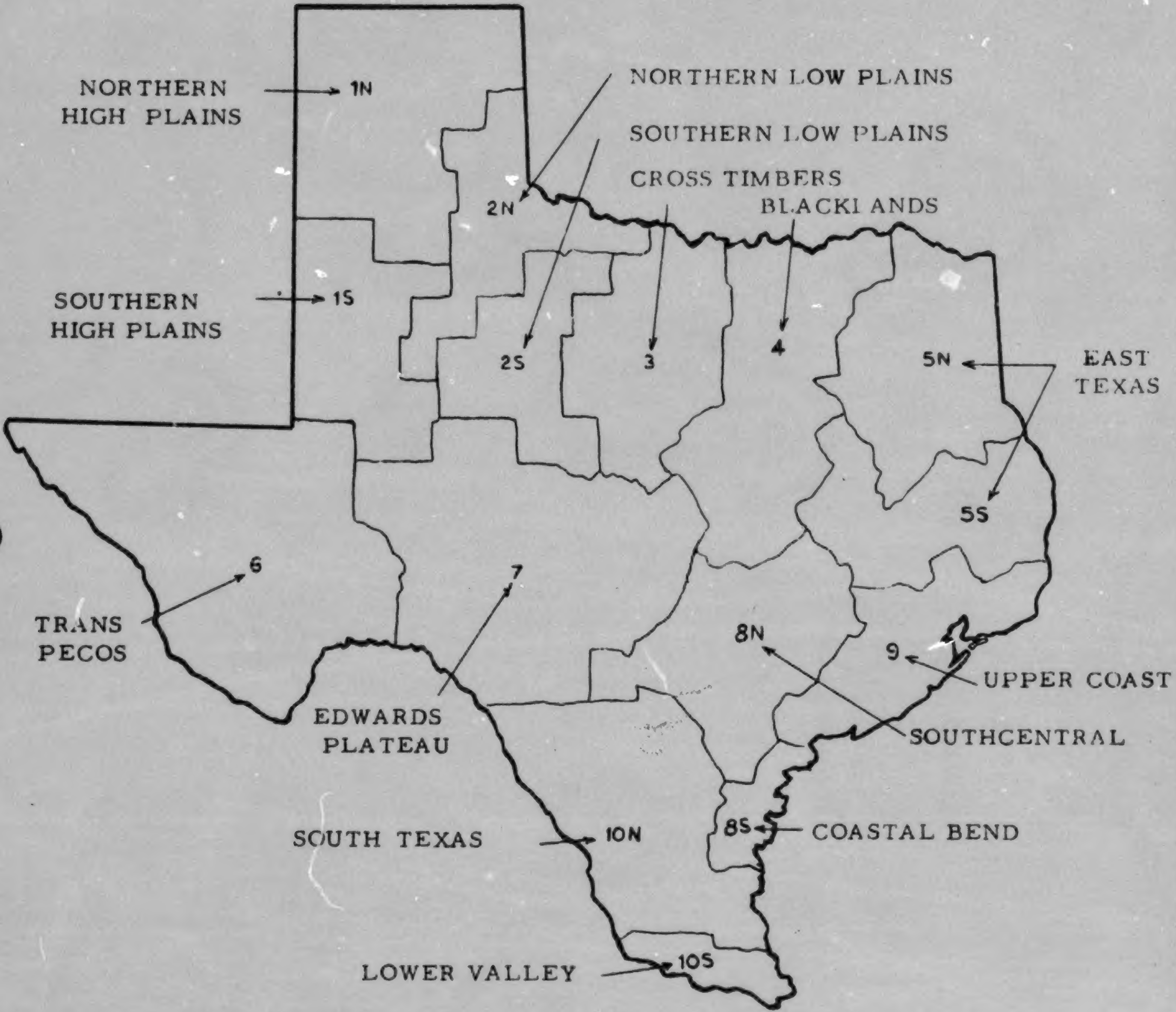
CROP	UNIT	ACRES
COTTON	4,246,000 bales	5,034,500
GRAIN SORGHUM	319,780,000 bushels	5,420,000
WHEAT	44,000,000 bushels	2,000,000
RICE	22,122,000 (100 lb. bags)	468,000
CORN	39,560,000 bushels	460,00
BARLEY	1.980,000 bushels	60,000
RYE	630,000 bushels	35,000
PEANUTS	480,455,000 pounds	307,000
COTTONSEED	1,665,000 tons	5,034,500
FLAXSEED	165,000 bushels	15,000
SOYBEANS	5,460,000 bushels	210,000
COWPEAS	14,000,000 pounds	22,000
SUGARBEETS	578,000 tons	24,600
HAYS	4,109,000 tons	1,970,000
VEGETABLES	244,200 dollars	147,726,000 (dollars*)
CITRUS FRUIT	15,000,000 boxes	32,338,000 (dollars)*
PEACHES	604,000 bushels	3,190,000 (dollars)*
PECANS	65,000,000 pounds	25,500,000 (dollars)*

* Value of Crop

MAJOR CROPS PRODUCED IN THE UNITED STATES
Statistical Information - 1972
Table 2

CROP	UNIT	ACRES
COTTON (LINT)	10,473,000 bales	11,094,000
GRAIN SORGHUM	743,000,000 bushels	13,463,000
WHEAT	1,639,516 bushels	47,555,000
RICE	91,000,000 cwt.	2,128,000
CORN	5,540,253,000 bushels	54,573,000
BARLEY	462,484,000 bushels	9,388,000
RYE	50,935,000 bushels	1,334,000
PEANUTS	2,553,000 pounds	1,447,000
COTTONSEED	4,000,000 tons	11,094,000
FLAXSEED	24,000,000 bushels	2,627,000
SOYBEANS	1,117,000 bushels	40,857,000
DRY BEANS	19,000,000 cwt.	1,481,000
TOBACCO	1,751,000 pounds	921,000
SUGARBEETS	29,000,000 tons	1,575,000
SUGARCANE	130,954,000 tons	643,000
HAYS	127,000,000 tons	66,200
OATS	875,775,000 bushels	18,003,000
IRISH POTATOES	316,083,000 cwt.	1,404,000
VEGETABLES	3,911,560	2,671,576,000 (dollars)
CITRUS FRUITS	254,840,000 boxes	744,300,000 (dollars)
PECANS	(unavailable)	77,730,000 (dollars)

TEXAS CROP REPORTING DISTRICTS


NORTHERN HIGH PLAINS
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NORTHERN LOW PLAINS
SOUTHERN LOW PLAINS
CROSS TIMBERS
BLACKLANDS
2N
SOUTHERN HIGH PLAINS
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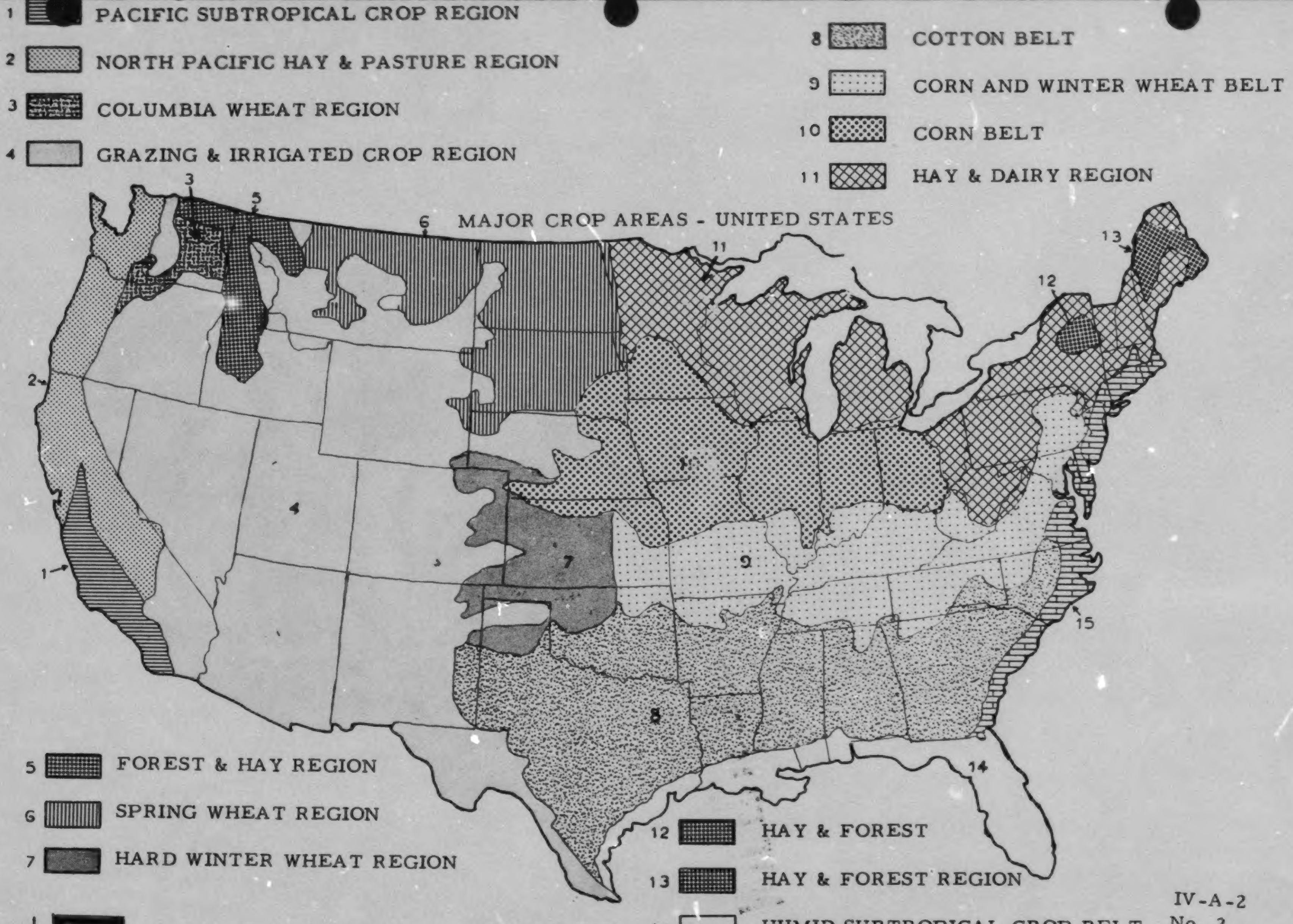
2S
3
4
5N
EAST TEXAS
5S
6
TRANS PECOS
7
8N
9
UPPER COAST
EDWARDS PLATEAU
SOUTHCENTRAL
SOUTH TEXAS
10N
8S
COASTAL BEND
LOWER VALLEY
10S



MAJOR CROP AREAS - UNITED STATES

1 PACIFIC SUBTROPICAL CROP REGION
2 NORTH PACIFIC HAY & PASTURE REGION
3 COLUMBIA WHEAT REGION
4 GRAZING & IRRIGATED CROP REGION
5 FOREST & HAY REGION
6 SPRING WHEAT REGION
7 HARD WINTER WHEAT REGION
8 COTTON BELT
9 CORN AND WINTER WHEAT BELT
10 CORN BELT
11 HAY & DAIRY REGION
12 HAY & FOREST
13 HAY & FOREST REGION
14 HUMID SUBTROPICAL CROP BELT
15 ATLANTIC TRUCKING REGION
1
2
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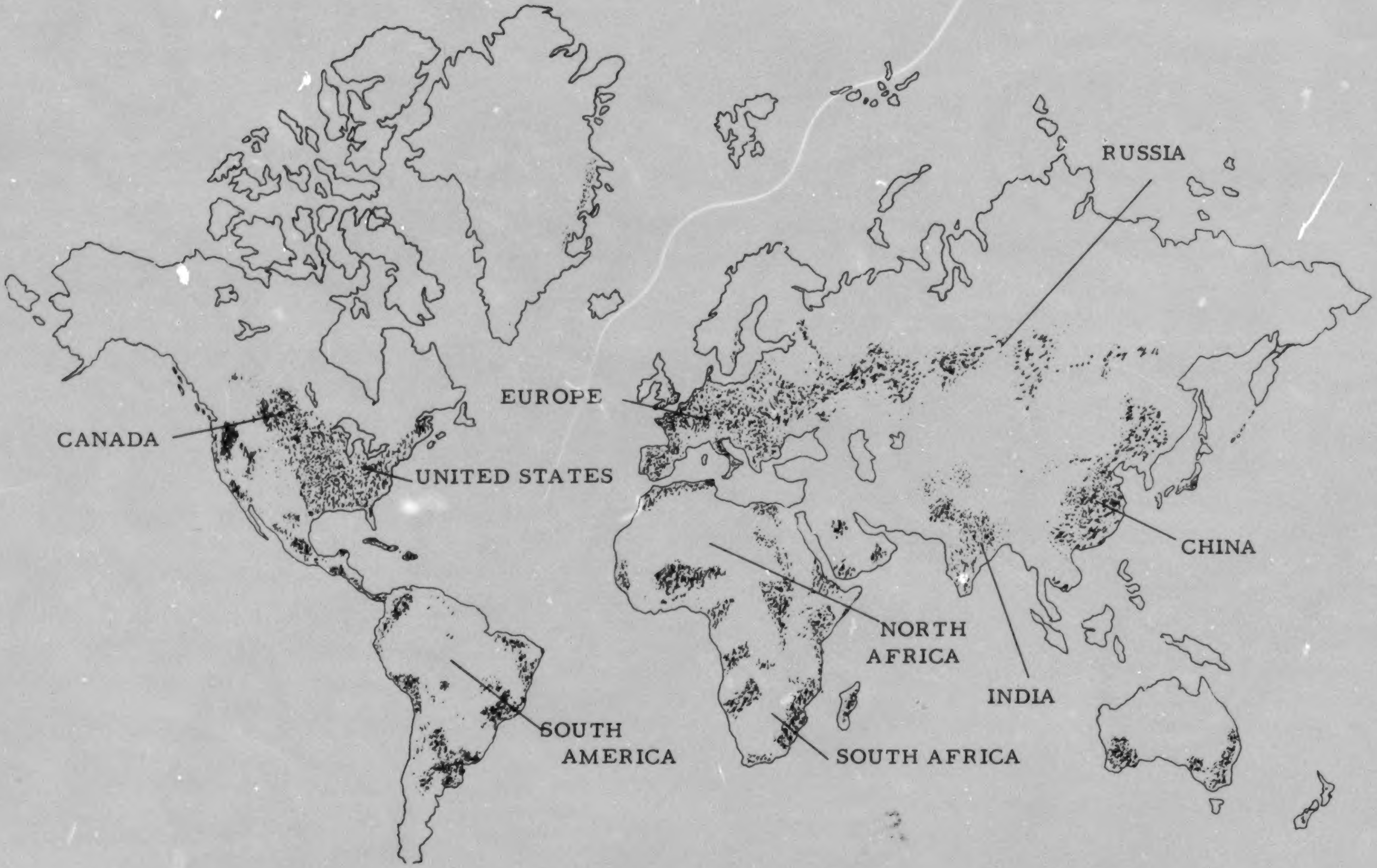
IV-A-2
No. 2

MAJOR CROP AREAS - WORLD


RUSSIA
EUROPE
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UNITED STATES
CHINA
NORTH AFRICA
INDIA
SOUTH AMERICA
SOUTH AFRICA

V. A. I

IV-A-2
No. 3

PLANT SCIENCE

Unit A: Introduction

Topic 3: Major Uses of Major Crops - Location of Processing Areas and Crop Consumption

Suggested Procedure and Activities: The use of transparencies or writing world population figures on the chalk board may be helpful in presenting the lesson.

1. How Important is the Crop Plant to Man?

a. Man and his domesticated animals have always depended upon the plant as an important source of a food supply. Man's past and present experience with plants is:

He has used more than 3,000 species of plants since he began domesticating crops for food and fiber.

He has cultivated about 150 species for food and fiber.

He only uses about 12 major crop plants as food and fiber for himself and feed for his animals.

b. Crop plants are important for the following reasons:

Provide a major source of food and fiber for man and animal
Aid in the protection of soil
Aid in beautifying certain surroundings
Provide a more efficient use of land area
Provide many types of occupations and jobs for man

c. Seventy-five percent of the calories in the diets of people in underdeveloped parts of the world come from cereals, potatoes, sweet potatoes, yams, cassava, and other tropical crops. In the developed countries of the world only 35 percent of the calories in a diet are provided by starch foods.

2. What Are the Major Crop Plants Used as a Source of Food Supply?

Crop plants used as food are grouped in the following classes:

Cereals (rice, wheat, and corn)
Sugar plants (sugarcane and sugarbeets)

Root crops (potatoes, sweetpotatoes, and cassava)
Tree crops (bananas and coconuts)
Oil seed legumes (soybeans and peanuts)
Oil seed - other (cottonseed and african palm)
Pulses (dry beans, chic peas, and broadbeans)

3. Uses and Processing Areas of Major Crops

a. Rice leads all other crops as a basic food. Over one-half of the world's population (more than a billion people) depend upon rice as a basic cereal.

The average annual per capita consumption of rice in the U.S. is about 7 pounds. In the Orient the consumption is between 200 and 400 pounds.

Good quality rice is used for food. The bran layer and germ is used as livestock feed.

The major rice milling areas are: Japan, China, India, Near East, Western part of the Western Hemisphere, and the United States.

b. Sorghum is considered a livestock feed crop in the U. S. In many Asiatic and African countries 75 percent of the acreage is devoted to grain sorghum for food purposes.

Grain sorghum is used as a food crop in India, China, and Africa.

The U. S. uses of grain sorghum are: livestock and poultry feed, alcohol, flour for wallboard, glue, tapioca, and oil.

c. Corn is considered a livestock feed in the U. S.; about 90 percent is fed to livestock, and 10 percent is used to provide food for human consumption.

About 33 pounds per capita of corn is consumed annually in the U. S.

Corn products include: chemicals, syrup, oil, starch, sugar, alcohol, and meal.

Corn is grown and processed in Africa, South America, Mexico, Europe, and parts of Asia. The largest processor is the United States.

d. Wheat is considered the most important food crop in the United States and Europe. Unlike corn, it is used for food instead of being used as a livestock feed.

The average wheat consumption per person in the U. S. is about 120 pounds per year.

Nearly all wheat in the world is made into flour. The yield of flour is 70 to 75 percent of the total weight.

The by-products of flour milling are: bran, middlings, and shorts.

Wheat is used to make sugar, alcohol, germ oil, and breakfast cereal.

Winter wheat is used for fall and winter pasture.

The major wheat processing countries are: United States, Canada, Russia, Australia, Europe, and Argentina.

Wheat is also used as a food in India, China, Egypt, and Northern Africa.

e. Barley, oats, and rye are used mainly for livestock grazing and hay.

Barley is an excellent livestock feed except when fed alone to horses. If fed alone it may cause colic.

Malt is one of the uses of barley grain. Malt sprouts and distiller's grain, a by-product of the brewing industry, are used in dairy feeds.

Oats are used as a superior feed for horses, breeding animals and young stock.

About four percent of all oats produced in the U. S. is used as food for human consumption.

About 40 percent of the rye acreage is used for grain. The grain is used to make flour and alcohol. The straw is useful in the manufacture of paper.

Barley, oats, and rye are processed and used mainly as a livestock feed in Russia, United States, Canada, and Europe.

f. Soybean, cottonseed, and peanuts are considered major oil crops of the world.

There are about 15 industrial uses, 12 human food uses, and five livestock uses of the soybean.

Soaps, plastics, paints, lubricants, flour, oils, meal, and cake are a few of the major uses of soybeans.

The largest producer is the United States, with 38 percent of the world production, and it is the largest processor of soybeans. China, Manchuria, Korea, and Japan also are large processors.

Cottonseed is the second most important oil crop for the U. S. and the world.

The many uses are: soaps, cosmetics, paintbase, linoleum, oleomargarine, cooking oils, and cottonseed cakes and meals.

The United States is the largest processor of cottonseed in the world. South America, Central America, Egypt, and Australia also process large quantities to extract the oil.

Peanuts are processed mainly for oil and meal. Peanut oil is used in a similar way as soybean and cottonseed oil, that is, for human consumption. Peanut meal, like soybean and cottonseed meal,is also used as a livestock feed.

g. Irish potatoes are recognized as an important food crop in the U. S. The average per capita consumption has been about 120 pounds annually.

About 60 percent of the potato is consumed as a table food. About 23 percent is processed for human consumption and only three percent used as a livestock feed.

Irish potatoes are grown and processed in Canada, South America, Europe, and Russia.

h. Tobacco is used in many ways by man. The different forms for use are: pipe, cigarettes, cigars, chewing, dipping (powder or dust form); and as a toxic alkaloid, nicotine is used as an insecticide.

Leading countries that manufacture tobacco products are: United States, China, India, Russia, Brazil, Turkey, Pakistan, and Japan.

The annual per capita consumption is 11.3 pounds.

i. Cotton is produced mainly for fiber. Almost 40 percent of the world's cotton is produced in the United States. Other leading cotton-producing countries are: Russia, India, China, Egypt, and Brazil.

Processing factories are located in many countries of the world. Large spinning and weaving factories are located in Japan, Western Europe, and India.

Other than cloth, cotton products are used in making explosives, plastics, rayon, paints, and paper furniture.

The annual per capita consumption in the U. S. is 23.5 pounds.

j. Sugarbeets and sugarcane are crops used to produce sugar. The annual per capita consumption of sugar is 105 pounds. Sugar plant juices are used to make syrups.

Several uses of sugar from sugar crops are: as a sweetener, making syrups, processing fruits, making beverages, making pastries, making candies, and processing dairy products.

Many Central American, South American, and Carribbean countries send crude sugar to the U. S. for refining.

Sugar mills are located in the United States, South America, Central America, the Carribbean, Africa, and the Far East.

k. The average per capita consumption of food may vary a small degree each year. It has been estimated that a person will consume the following amounts annually:

Fruits and vegetables - 1/2 ton
Flour, cereal products, sugar, oils, and potatoes - 4/5 ton
Dairy products - 3/4 ton
Meats - 1/2 ton

Transparency No. 1

4. What will be the Potential Crop Production Needs by 1980?

a. If the population increases as projected, the gain in the number of people will be greater from 1960 to the year 2000 than it has from the beginning of man to 1960. In 1960 the world population totaled 2,913,000,000. By the year 2000 it is estimated there will be 6,267,000,000 people in the world.

b. By 1980 farm exports may expand as much as 35 percent, and local use of farm products will expand at least 30 percent above the 1965 levels. Food consumption is expected to increase as follows over a period of 15 years (1965-1980):

Beef - 40 percent
Pork - 25 percent
Poultry - 45 percent
Soybeans - 75 percent
Potatoes - 25 percent
Corn - 55 percent
Wheat - 25 percent
Cotton - 10 percent
Rice - 19 percent
Dry beans - 17 percent

It is also estimated that 50 percent more feed grains and 25 percent more hay will be needed in the livestock program by 1980 as compared to 1965.

References:

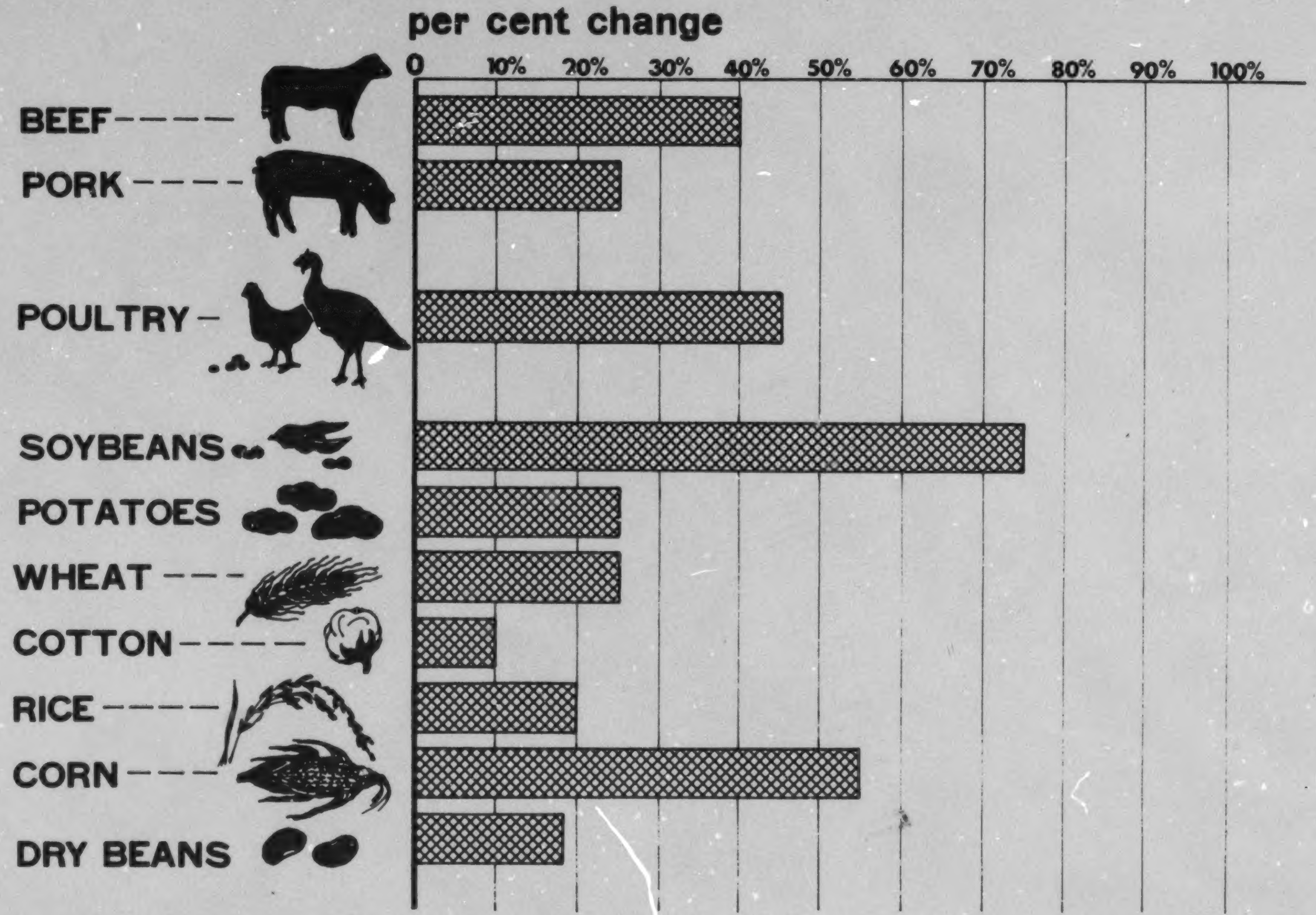
1. Delorit, Richard J., and Henry L. Ahlgren, Crop Production, Prentice - Hall, Inc., Englewood Cliffs, NJ, 1967.

2. Hughes, Harold D., and others, Crop Production Principles and Practices, The Macmillan Company, NY, 1967.

3. Statistical Abstract of the United States, Superintendent of Documents, Washington, D.C., 1970.

4. Agricultural Statistics, Superintendent of Documents, Washington, D.C., 1967.

POTENTIAL PRODUCTION NEEDS
LIVESTOCK & CROP 1965-1980



PLANT SCIENCE

Unit B: Plant Growth

Topic 1: Plant Structure - Function of Plant Parts

1. A Comparison of Plant and Animal Growth

a. Most plants are multicellular. That is, they are made up of many millions, or even billions, of cells. The division and enlargement of these many cells result in growth of the plant. In order to grow, the plant must have plant nutrients in the form of raw materials. These include carbon dioxide, water, oxygen, nitrogen, phosphorous, and other minerals.

b. Plant cells vary in shape, size, and even in the nature of material that forms the cell walls. Yet, in chemical composition and chemical changes they are similar to animal cells.

c. Both plants and animals breathe. The organism supplies its cells with oxygen needed for metabolism and relieves them of carbon dioxide formed in the energy-producing reactions.

Transparency No. 1

d. The main parts of a plant are similar to the main organs of the animal. The lungs, heart, and digestive organs perform functions for the animal's body; roots, leaves, stems, and flowers of plants perform special functions for the total plant.

e. Both plants and animals use protein, fats, and carbohydrates for energy and growth.

f. Plants differ from animals in their ability to use carbon dioxide in manufacturing food. Also, they can build up valuable organic substances from simple materials.

2. The Major Parts of a Plant and Their Functions

Transparencies Nos. 2 and 3

a. Root - The primary functions of the plant root are: absorbing water and plant nutrients from the soil, serving as a food storage component of the plant, anchoring the plant, and serving as a plant support structure for the leaves and fruit.

The types of roots:

Soil roots are classified in two main types: tap (cotton, carrot, and most woody plants) and fibrous (grasses and cereal plants). Most monocotyledons have fibrous root systems. Non-soil roots are: aerial (ivy), aquatic (water lily), and cypress knees (projection from cypress tree roots). The roots may not be noticable even though it could consist of one-half the weight of the entire plant.

The method of growth is as follows:

At the end of each root is a root cap, which is free of root hairs. The embryonic, or growth, region pushes the root cap through the soil. The maturation region that contains the many root hairs is not pushed through the soil. Root hairs are continuously formed and die off as the root develops. The root hair is a tiny one-cell hair-like growth near the end of the root. It contains a nucleus surrounded by a cell wall. The small root is composed of cytoplasm (protoplasm made up of protoplast) and vacuoles (sap-filled cavities in the protoplasm). A mass of protoplasm in a single cavity is called a protoplast. The root hair absorbs water and minerals that are used by the plant. Under certain conditions this process is known as osomosis.

Root growth is influenced by available soil moisture, soil fertility, and soil aeration.

Roots grow better in a soil which has an adequate supply of moisture but is not water-soaked.

Soil fertility and acidity determines the rate of growth of the plant root system. Adequately fertilized plants produce food in the leaves which supplies energy for the roots to develop in the soil.

Soil aeration and structure is considered very important to root growth. The lack of oxygen retards root growth and prevents the production of root hairs. Hardpans and compacted soils tend to limit root growth.

Root tissues and their functions:

Tissue	Functions
Epidermis	absorption, protection
Secondary root	branch of main root-transports food stuff and anchors plant
Cortex	stores food and water
Endodermis	boundary layer

Pericycle	origin of secondary roots
Phloem	conducts food downward from leaf to stem
Cambium	increases growth in diameter of root
Xylem	conducts water and dissolved food upward to stem and leaves

Transparency No. 4

b. Stem - The major functions of a stem include: supporting the leaves and fruit, conducting manufactured plant food (water and dissolved substances) from the leaves to other parts of the plant, and serving as a food storage area in some plants.

How stem growth starts:

Growth starts as buds of plants. It takes place at the tip or end of the shoot known as the terminal bud.

The bud is considered a portion of the stem which develops at the end of the internode, or at the node. It is defined as a stem, branch, rudimentary leaf, and unexpanded flower. An auxiliary bud is located between the main stem and the petiole. Most stems are jointed at the node. This area of the stem is usually solid and thick, and it contains food material stored at the base of the leaf.

Growth in diameter of grasses and cereal plants is due to cell enlargement, whereas in dicotyledonous crop plants growth in stem diameter is from cell enlargement and cell division in the cambium layer.

The bud of the plant is often referred to as the embryonic stem. Usually growth takes place at terminal or lateral buds. Adventitious buds are found on stems, leaves, and roots between the nodes. Plant injury can cause the growth of adventitious buds. Not all buds on a plant are active. As some buds mature they become dormant.

Many plants have modified stems; that is, the stem is not an upright cylindrical type structure. Underground modified stems of crop plants are in the form of rhizomes or rootstalks. This type of stem is long and bears scales at the nodes. Examples of plants that bear rhizomes are johnsongrass, bermudagrass, Canadian thistle, and quackgrass.

Stolons are modified stems that grow horizontally along and above ground. They originate at the base or crown of the plant. Roots and shoots develop at some of the nodes on stolons of certain plants. Some examples of stolon type plants are clover, strawberry, and buffalograss.

Tubers are another type of modified stem. They may be identified as the fleshy part of a rhizome. The white potato and Jerusalem artichoke are classed as tubers. The eyes on a potato are made up of a rudimentary leaf and buds.

The function of stem parts:

Tissue	Functions
Phloem	sieve tubes - conduction of food materials
Xylem	conveys water and supports plant
Vascular bundles	contains the xylem and phloem - veins that conduct water and nutrients
Cortex	stores food and water and conducts food
Pith cells	food storage
Petiole	stem - supports leaf
Abscission layer	layer that disjoins leaf or fruit from stem area - bears leaf and axillary buds - storage of plant material
Internode	stem area - storage of plant material and supports other plant parts

Transparency No. 5

c. Leaf - The leaf manufactures plant food (carbohydrates) through a process known as photosynthesis. With nitrogen and minerals from the soil and sugars produced by photosynthesis, the leaf can produce protein. The chemical equation for photosynthesis is sunlight + $6 CO_2 + 6 H_2O$ —— $C_6H_{12}O_6 + 6 O_6$ is glucose. CO_2 is taken in by the small leaf openings.

Another function of the leaf is transpiration. Almost all the water taken in by the plant roots is transpired through the leaves. In some plants food is stored in the leaves.

One of the best methods used to identify plants is the use of plant leaves. There are two major types of green leaves - parallel-vein (grasses) and netted-vein (crop plants except grass plants). The primary parts of a leaf are the blade (lamina) and the leaf stalk (petiole). The two small leaves found at the base of the leaf stalk are known as stipules. The type of leaf margin, base, tip, and shapes are used to identify plants.

Leaves vary in size and shape. They may be needle-like as on the conifers, flat thin blades as on hard-wood trees, or heavy fleshy stem - like parts of the cactus plant. Leaves are the edible portion of many plants.

Transparency No. 6

d. Flower - The most important function of the flower is the reproduction of seed. Pollination takes place in the flower on plants that are naturally self-pollinated, naturally cross-pollinated, and often cross-pollinated. Fertilization also takes place in the plant on flower parts. The stamen and pistil are the reproductive parts of a flower. A complete flower will have the following four parts: sepals, petals, stamens, and pistil.

A flower is considered incomplete if it lacks one or more of the complete flower parts. Perfect flowers contain the stamen and pistil. A perfect flower may lack the corolla or calyx. An imperfect flower lacks either a stamen or pistil. A corn plant has separate staminate and pistillate flowers on the same plant. Buffalograss has staminates and pistillates borne on completely separate plants.

The inflorescence is the flowering part of the plant. Flowers are usually arranged differently on different plants; therefore, there are many common types of inflorescences. Some of these types are as follows:

Spike - This type of inflorescence is almost without pedicels (internodes below flower). The small forms of spikes on highly specialized grasses are called spikelets. Wheat has this type of flower cluster.

Raceme - The new flower buds are constantly supplied at the tip, and the older flowers are located below the new buds in this flower arrangement. An example of this cluster is the radish.

Panicle - This is a compound type of inflorescence. It may be thought of as a composite of spikes, racemes, or corymbs. Rice flower arrangement is a compound type of arrangement.

Corymb - In this flower arrangement, the pedicels are longer on the lower flowers. The flowering cluster causes a flat-topped arrangement. The flowering buds are inside and the fruits outside while the plant is still in the blooming stage. The cherry plant has this type of flower arrangement.

Cymes - Cymes are determinated inflorescences; that is, the terminal bud becomes a flower and this part of the plant does not continue to grow. Examples of cyme inflorescences are simple umbels (onion), compound umbels (carrot), and heads of ray flowers (sunflower).

Transparency No. 7

e. Fruit and Seed - The major function of fruit and seed are the same as the flower - to reproduce the plant. The fruit of a plant is considered a mature ovary. A mature ovary contains mature ovules or seed. The simple fruit has a single ovary. The ovary wall (pericarp) is composed of three layers: the exocarp (outside layer), mesocarp (middle layer), and endocarp (inner layer). The juicy edible part of a citrus fruit is the endocarp. The endocarp of a peach is the seed, and the edible flesh is the mesocarp. If the pericarp is attached or fused to the seed as found in wheat, corn, and most grasses, the fruit is called a caryopsis. This type of fruit is composed of the following parts: endosperm (food storage tissue), pericarp, seed coat, and embryo.

The seed has been defined as a miniature plant in a dormant stage. The main parts of a seed are the seed coats, food storage tissue or endosperm, and embryo. If the stored food (fats, carbohydrates, and proteins) is absorbed by the maturing embryo, the cotyledons become the food storage organs. For example, the food storage areas in beans and cow peas are the cotyledons.

3. Plant Cell

a. The plant cell is the basic structural unit of the plant. There are many functions of the cells in plants. Some cells serve for absorption, plant strength and support, food making, food storage, and conduction of plant materials.

Transparency No. 8

b. The plant cell consists of a mass of protoplasm and nucleus confined within a cell wall. Protoplasm is the living matter of a cell. It consists of a liquid chemical mixture of water, starches, sugars, fats, proteins, and mineral salts. The cell is where plant life takes place. The cell parts are listed below:

Tissue	Function
Cell Wall	Non-continuous membrane that surrounds plasma membrane
Plasma Membrane	Surrounds cytoplasm (protoplasm) within the cell wall
Chloroplast	Specialized colored bodies (chlorophyll) in cytoplasm
Vacuole	Cavities in cytoplasm filled with cell water
Nucleus	A small round body within a cell nucleus
Nucleolus	Body of specialized protoplasm containing chromosomes within a cell
Granule	A small particle within the vacuole

References:

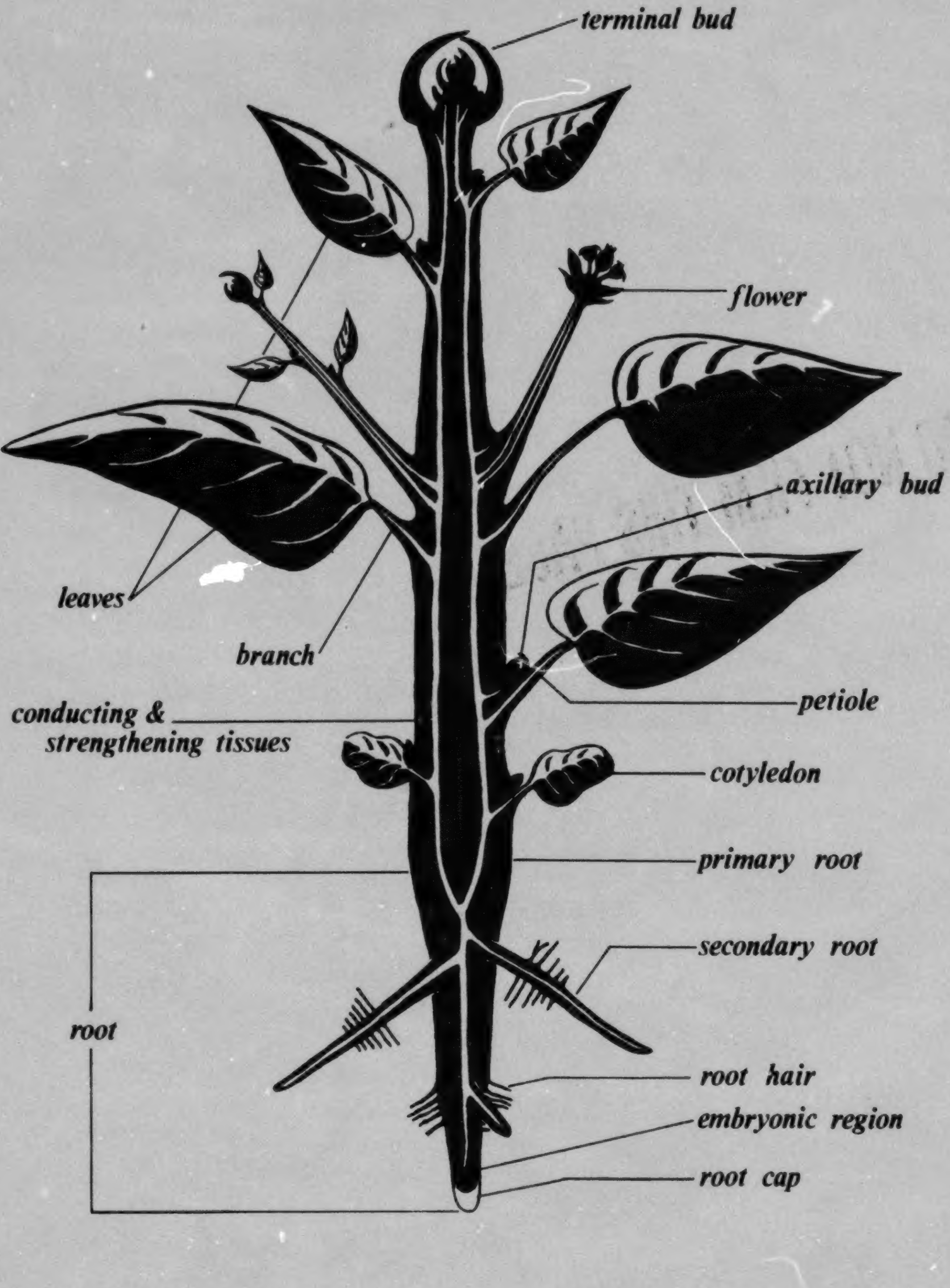
1. Fuller, Harry J. and Zane B. Carothers, The Plant World, Holt, Rinehart, and Winston, Inc., New York, NY, 1967.

2. Janick, Jules, Horticulture Science, W. H. Freeman and Company, San Francisco, CA, 1963.

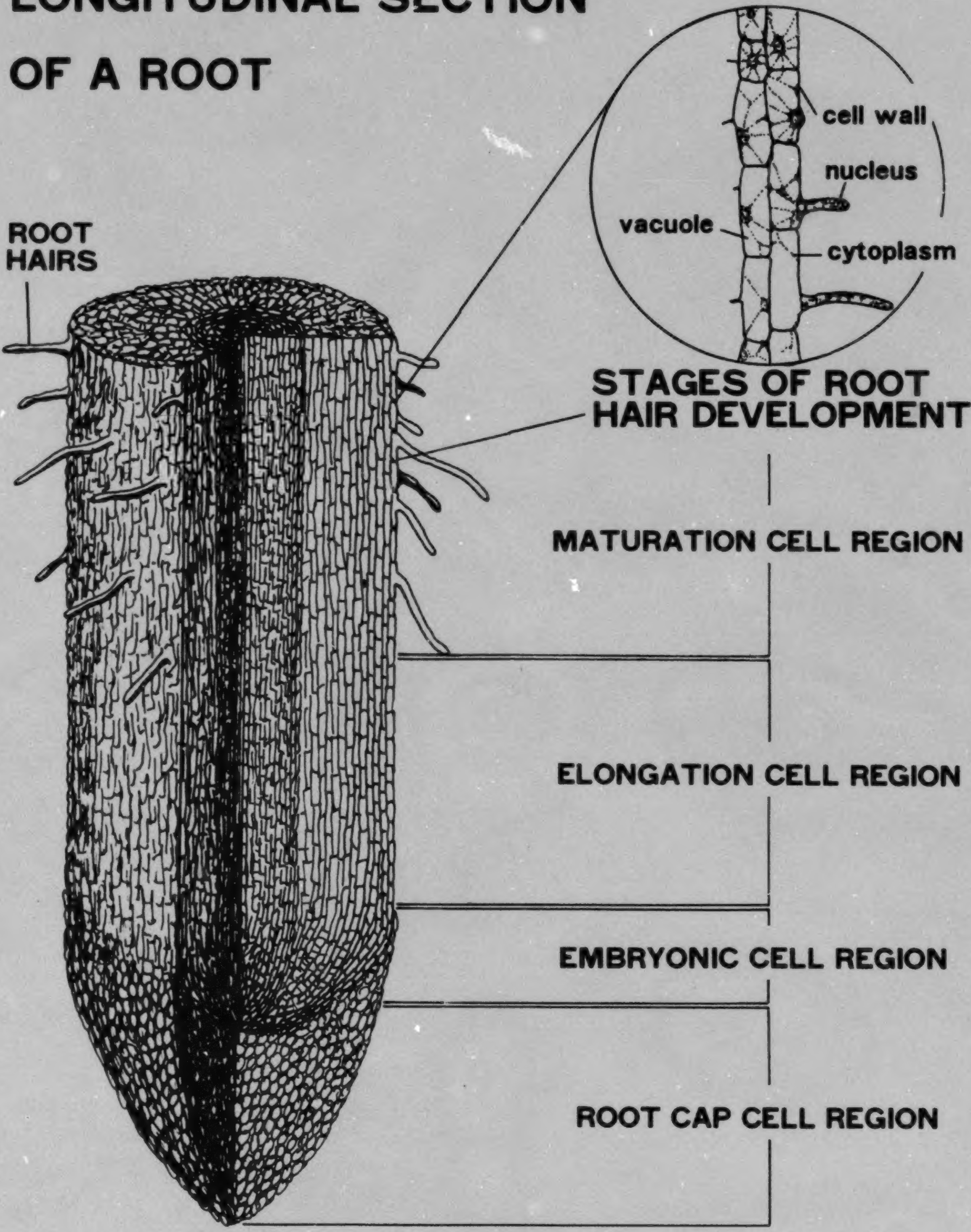
3. Klingman, Glenn C., Crop Production in the South, John Wiley and Sons, Inc., NY, 1967.

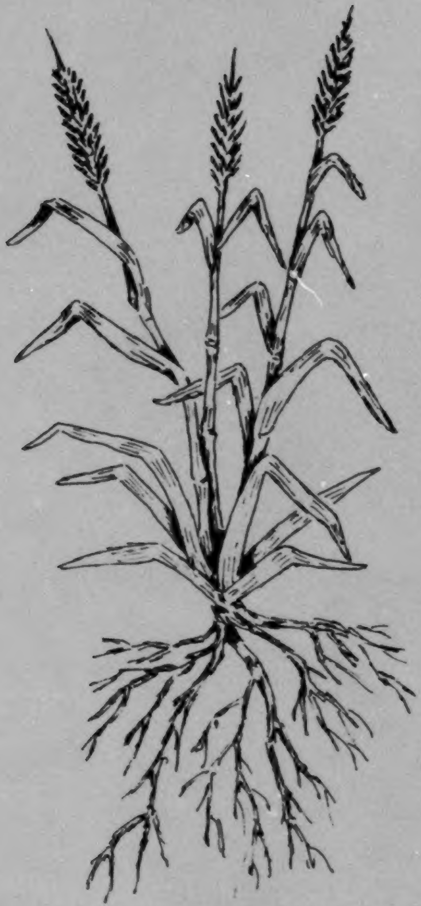
4. Hughes, Harold D., and others, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1968.

FLOWERING PLANT

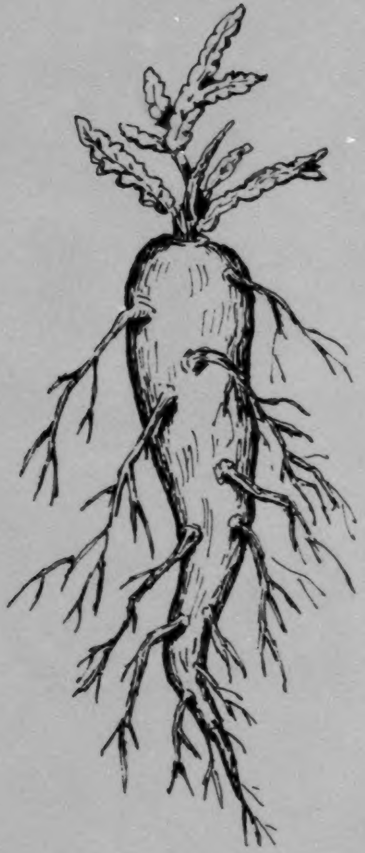

terminal bud
flower
axillary bud
leaves
branch
petiole
conducting & strengthening tissues
cotyledon
primary root
secondary root
root
root hair
embryonic region
root cap

LONGITUDINAL SECTION OF A ROOT


ROOT HAIRS
cell wall
nucleus
vacuole
cytoplasm
STAGES OF ROOT HAIR DEVELOPMENT
MATURATION CELL REGION
ELONGATION CELL REGION
EMBRYONIC CELL REGION
ROOT CAP CELL REGION

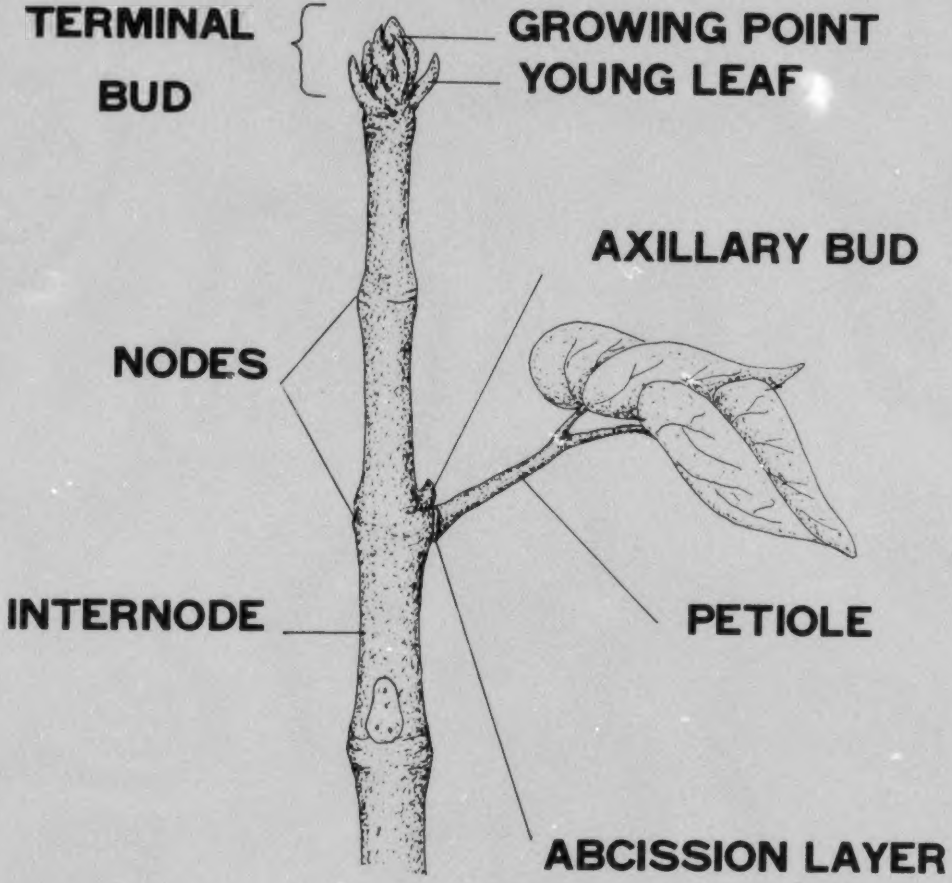


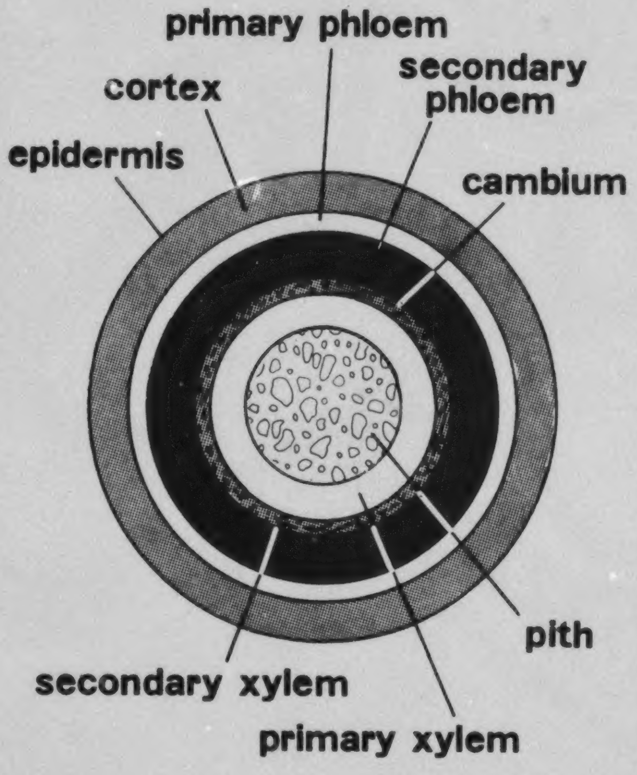
FIBROUS SYSTEM



TAPROOT SYSTEM

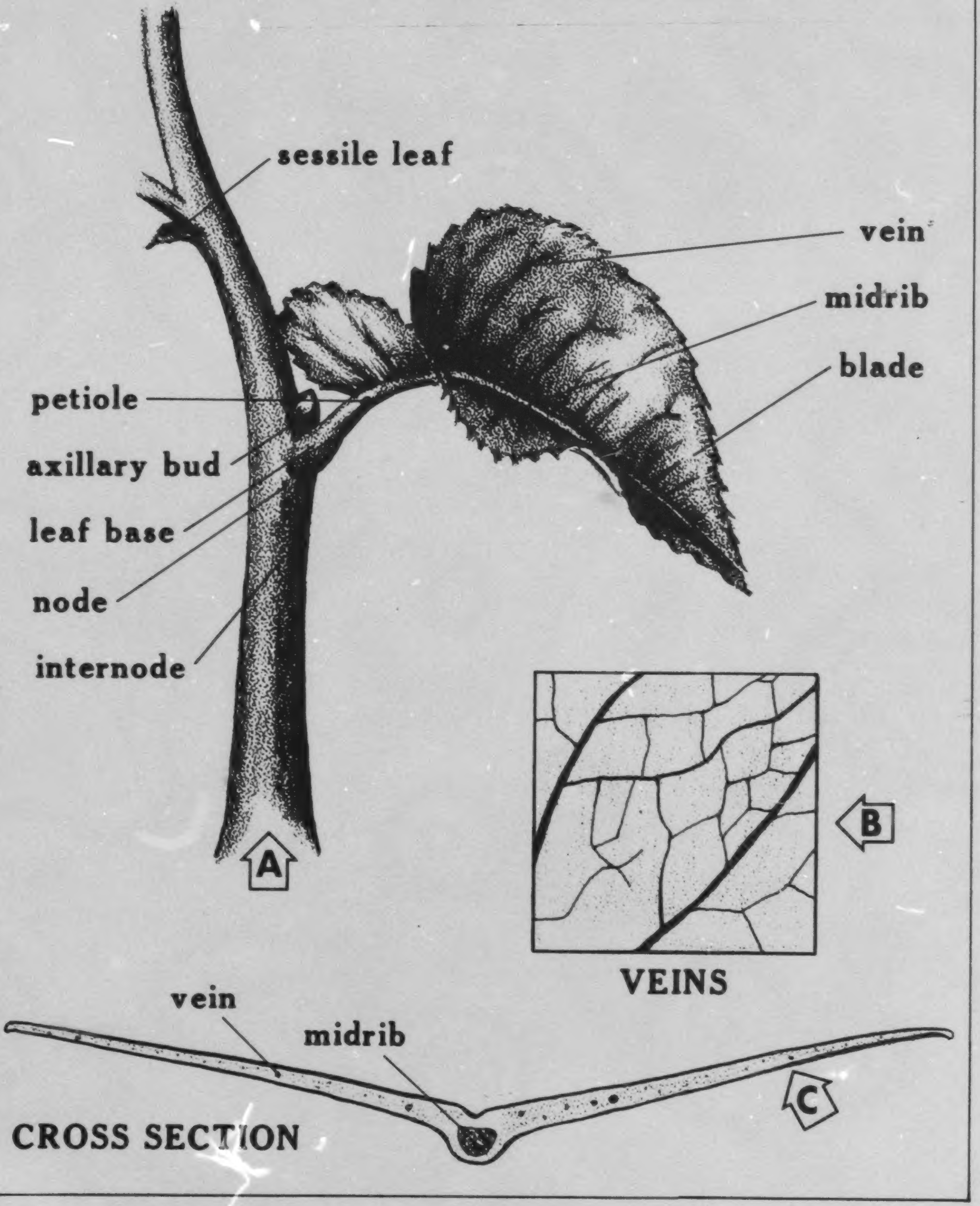
STEM GROWTH


TERMINAL BUD
GROWING POINT
YOUNG LEAF
AXILLARY BUD
NODES
INTERNODE
PETIOLE
ABCISSION LAYER

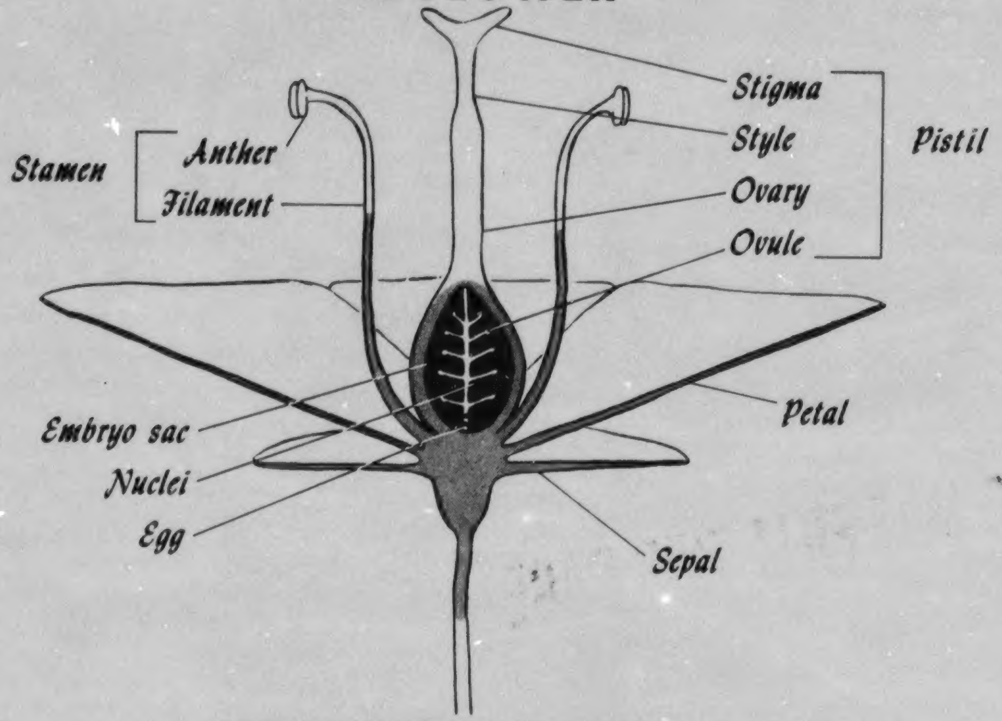

primary phloem
cortex
secondary phloem
epidermis
cambium
pith
secondary xylem
primary xylem

CROSS SECTION OF A STEM

LEAF MORPHOLOGY

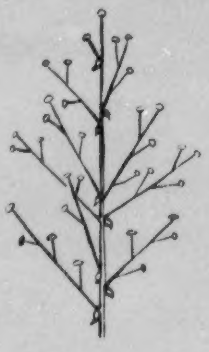

sessile leaf
vein
midrib
blade
petiole
axillary bud
leaf base
node
internode
A
B
VEINS
vein
midrib
C
CROSS SECTION

THE FLOWER

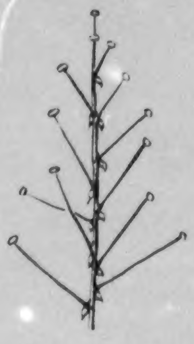

Stigma
Style
Ovary
Ovule
Pistil
Stamen
Anther
Filament
Embryo sac
Nuclei
Egg
Petal
Sepal

COMPLETE FLOWER

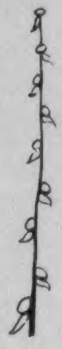
TYPES OF INFLORESCENCE



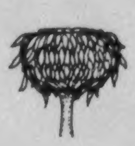
❶ *Panicle*



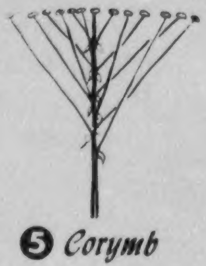
❷ *Raceme*



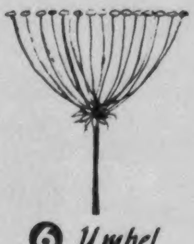
❸ *Spike*



❹ *Head*

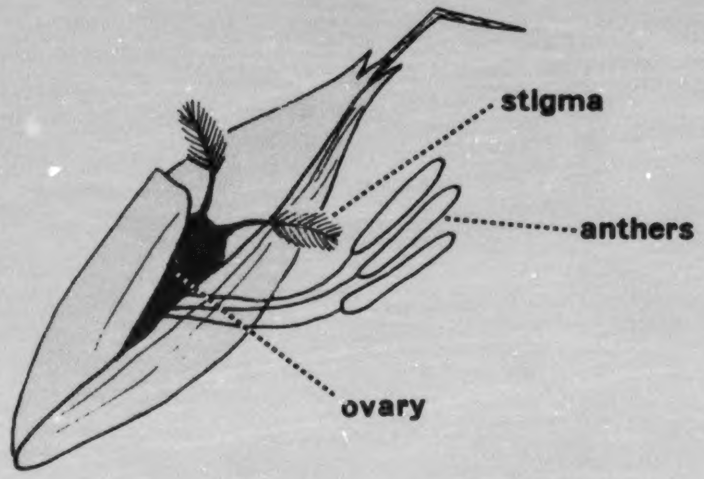


❺ *Corymb*

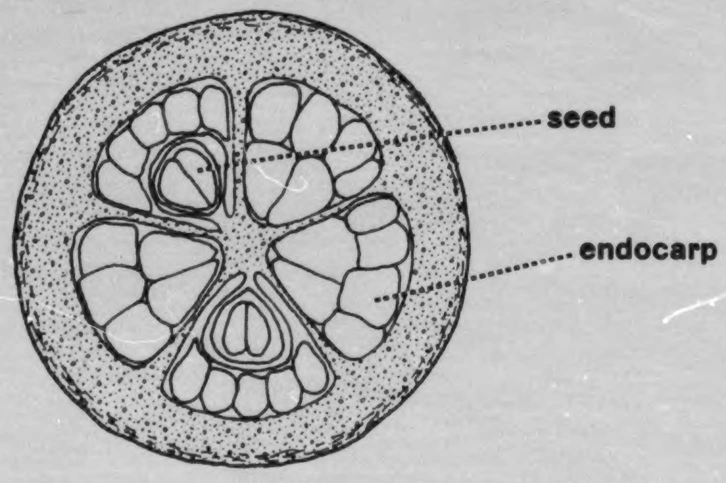


❻ *Umbel*

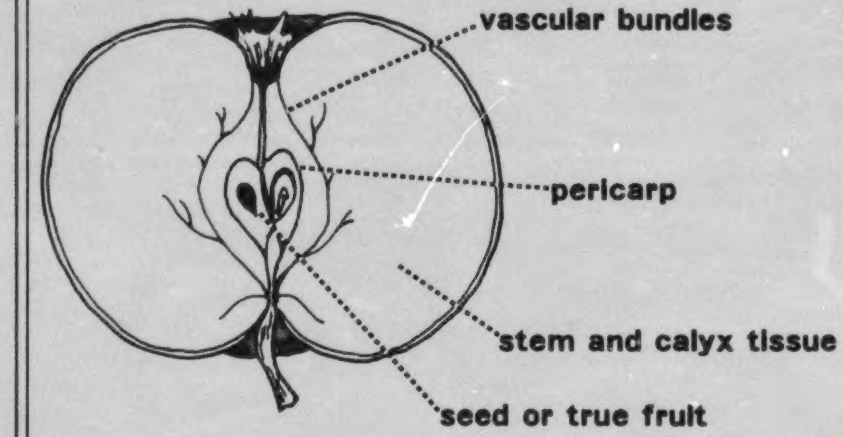
FLOWER, FRUIT, AND SEED


stigma
anthers
ovary

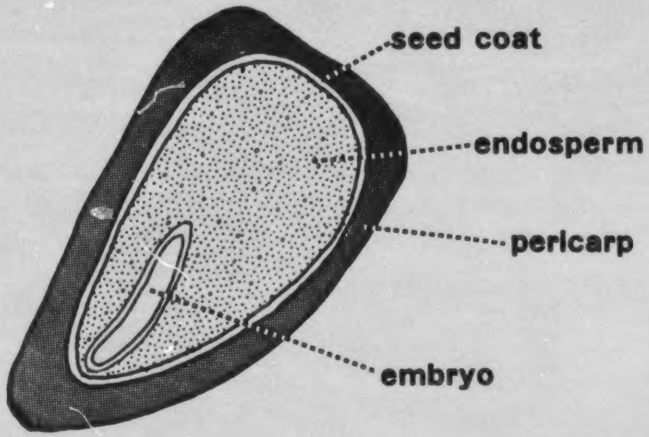
GRASS - INCOMPLETE FLOWER


seed
endocarp

CITRUS - EDIBLE ENDOCARP

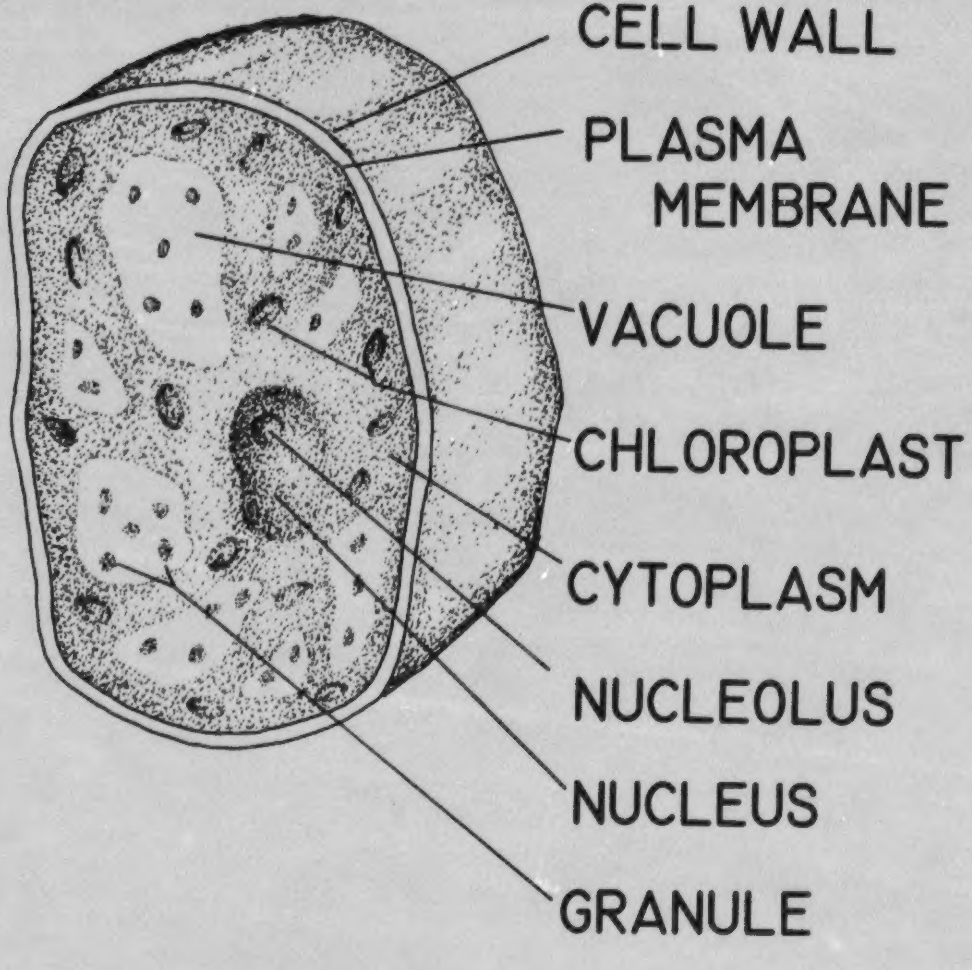

vascular bundles
pericarp
stem and calyx tissue
seed or true fruit

APPLE - EDIBLE CALYX TISSUE


seed coat
endosperm
pericarp
embryo

CORN - PERICARP FUSED TO SEED

THE PLANT CELL


CELL WALL
PLASMA MEMBRANE
VACUOLE
CHLOROPLAST
CYTOPLASM
NUCLEOLUS
NUCLEUS
GRANULE

Vocational Instructional Services
Agricultural Education

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PLANT SCIENCE

Unit B: Plant Growth

Topic 2: How Seeds Germinate

Suggested Procedures and Activities: Transparencies and germinating seeds may be used during the class discussion.

1. Why the Seed is Important

   a. The seed is a way of survival for the species. It contains an embryonic plant which is composed of the following parts: roots, hypocotyl (stem of embryo below cotyledons), and epicotyl (stem of embryo above cotyledons).

   b. It furnishes food for man and animal and other living creatures.

   c. The seed provides raw materials for the development of numerous products that are used by man and animal.

2. Conditions Necessary for Seed Germination

   a. Ample Supply of Moisture - Crop seed germinate when the moisture content range is between 26 and 75 percent.

      Grain sorghum and sudan grass seed will germinate when their moisture content reaches 26 percent.

      Small grains germinate when the seed moisture is about 50 percent.

      The soybean contains about 75 percent moisture before it germinates.

   b. Proper Temperature - Field crop seed will germinate at temperatures ranging from 32 to 120 degrees F. Most seed germinate at a temperature between 68 and 86 degrees F.

      Wheat, rye, barley, and oats, will germinate just above freezing.

      Field peas, alfalfa, soybeans, flax, and ceratin clovers will germinate at about 40 degrees F.

      Sorghum and corn germination temperature is about 48 degrees F.

c. Ample Supply of Oxygen - Most seed need oxygen to germinate. Rice seed will germinate if covered by water. Other small grain crops and cotton will not germinate if oxygen is not available. Oxygen deficiency can be increased by depth of planting.

The lack of oxygen can cause the seed to remain dormant for several years. Pure oxygen is harmful to seed in a similar way as it is harmful to man.

d. Proper Amount of Light - Light is not as important as moisture, correct temperature, and oxygen for seed germination. Some types of tobacco and grasses require light for germination.

The grasses that germinate better under light are: Bermudagrass, Kentucky grass, bentgrass, slender wheatgrass, and Canada grass. Most American varieties of tobacco will germinate in the absence of light. Some seeds such as pigweed and thorn apple germinate in the dark.

3. Conditions that Affect Seed Germination

a. Mechanical Injury - Seeds with damaged seed coats will either germinate abnormally or fail to germinate. Insects, rodents, heat, and mechanical harvesting may affect the seed coat.

b. Disease - Many diseases are caused by fungi or bacteria which affect plants. Seed become contaminated by air, water, and insects as they carry spores and bacteria to the plants.

c. Storage Conditions - Seed may become completely dehydrated if stored in a location that has high summer temperatures or high temperature due to artificial winter heating. Places that are too damp cause mold and other fungi conditions. Cool temperature and low moisture are ideal for seed storage.

d. Old Seed - Some seed will not germinate if it is over six months old. Most all crop seeds over a year old will not germinate, nor will fresh seed. However, some crop seeds will germinate when over a year old if the moisture content and temperature are low. The maximum period that seed remain viable is from two to ten years.

e. Temperature too Cold - Low temperature causes water to be absorbed slowly. The plant may use the stored food before it grown enough to manufacture its own food if the temperature is low.

f. Hard Seed Coat - Some plants produce seed with a hard seed coat. The seed coat will not permit water to enter the seed and bring about germination until the tough coat is scarified.

g. Drying Out of Soil - Water must be readily available to the seed for germination to take place. The seed will not germinate if the chemical processes that change the insoluble starches to soluble sugars fail to take place. The packing of a seed bed aids germination by preventing soil drying.

h. Planting too Deep - Seed that are planted too deep may germinate, but the plants will exhaust their food supply and die before reaching the surface. They cannot manufacture food without light.

i. Seed Dormancy - Seed in some crops fail to germinate immediately after they reach maturity. They must go through an after-ripening stage. Wheat, barley, oats, and some wild plants must pass through a period of inactivity before the germination will take place.

The causes of seed dormancy are:

Hard and thick seed coats prevent the absorption of water and the intake of oxygen. Many of the legumes have hard seed coats.

Embryos have not passed through all developmental stages in some seed even though they are mature. For example, in small grain crops the seed must pass through an after-ripening period before they will germinate.

Some seed coats interfere with the intake of oxygen. Dormancy in oats and barley is partly due to the lack of the seed absorbing oxygen.

Embryos are immature in some seed at harvest; therefore, a maturing period is necessary before the seed will germinate.

The dormancy period of hard seed is interrupted by scarification of the seed coat. The seed coat is scratched or broken by blowing and/or rolling the seed against an abrasive surface so that the seed coat is more permeable to water.

4. Seed Germination

a. Laboratory tests show that between 90 and 100 percent of the planting seed germinate. Cotton and grain sorghum may give a lower percent field germination due to being more susceptible to a fungi that causes the seed to rot. Many grass seed do not exceed 70 percent germination.

Transparency No. 1

b. Seed germination occurs when the young dormant plant or embryo begins to grow.

The first step is the absorption of water and oxygen into the seed. This process causes the seed to swell and increase in size.

Enzymes are secreted and these substances pass through a chemical process that converts the insoluble starches into sugars.

Soluble sugars dissolve in water and are used as a source of food for the tiny plant.

The germination process is as follows in dicotyledonous and monocotyledonous plants:

As the seed swells, the seed coat is ruptured, permitting the young root or radicle to grow downward.

Dicot - The seed coat, or testa, splits near the hilum. The young root becomes the primary root which forms lateral branches.

Monocot - The young root breaks through the coleorhiza or sheath. This first root system is temporary and is replaced later with an adventitious root system.

The upper part emerges from the soil or seedbed.

Dicots - The hypocotyl elongates as it curves forming an arch which pulls the cotyledons upward; the arch straightens after passing through the surface.

Monocots - The tight roll of leaves (pointed bud), the plumule, pierces the earth as it grows upward, and the first true leaf appears.

New leaves are formed and food is manufactured through the process of photosynthesis.

Dicots - The cotyledons spread apart and serve as leaves by transferring food to other parts of the plant. The plumule becomes exposed to air and light. Leaves develop on the plumule and the cotyledons shrivel as their stored food is used by the seedling plant. The stem, or epicotyl, and leaves continue to grow after shedding the cotyledons.

Monocots - After the plumule emerges, the first true leaf is formed and food production takes place in the new leaves. At this point the food supply has been exhausted from the endosperm and the plant manufactures its own food. In the monocotyledonous plant the food supply, the endosperm, is composed primarily of starch.

Forming of the Root System

Dicots - Branch roots form on the primary root to make a permanent root system of dicotyledonous plants.

Monocots - As already mentioned, the first root system is temporary in monocotyledonous plants. New secondary or permanent roots appear on the nodes below the ground surface, and the original root from the seed dies.

Transparencies Nos. 2, 3, 4, and 5

5. Two Types of Seed

A dicotyledon has two seed leaves in each seed, and a monocotyledon has only one seed leaf in its seed. A dicotyledon may be referred to as a dicot and a monocotyledon as a monocot.

Bean seeds are typical of dicots, and corn seeds are typical of monocots. Small grains, grasses, and pasture weeds, are monocots. Leguminous crops (alfalfa, beans, and peas) are dicots.

Comparison of Dicotyledonous and Monocotyledonous Seed

Bean	Corn
Has Testa (Seed Cover) with Hilum and Micropyle (opening in seed) plainly visible	Hilum (attachment scar) Covered by Fruit Coats
Two Cotyledons (Food for Seedling) (Seed Leaves)	One Cotyledon (Seed leaf)
Large Embryo	Small Embryo
No Separate Endosperm (embryonic secondary leaves)	Large Endosperm (Food for Seedling)
Plumule Fairly Large	Plumule Rather Small
Plumule Leaves Folded	Plumule Leaves Rolled
The Fruit a Pod, with Many Seeds	The Fruit a Single Grain with One Seed

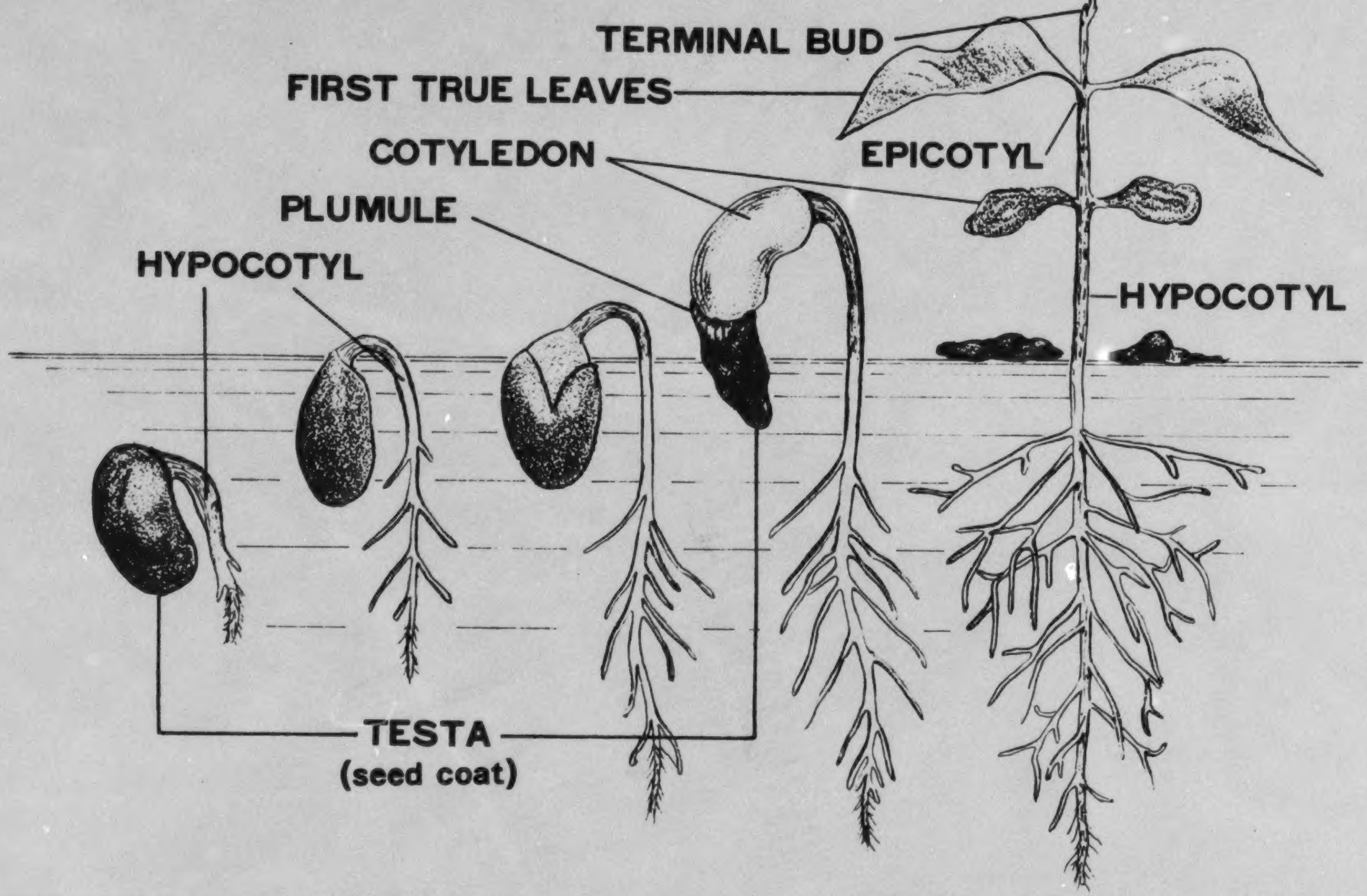
References:

1. Delorit, Richard J., and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.

2. Janick, Jules, and others, Plant Science, An Introduction to World Crops, W. H. Freeman and Company, San Francisco, CA, 1969.

3. Klingman, Glenn C., Crop Production in the South, John Wiley and Sons, Inc., New York, NY, 1967.

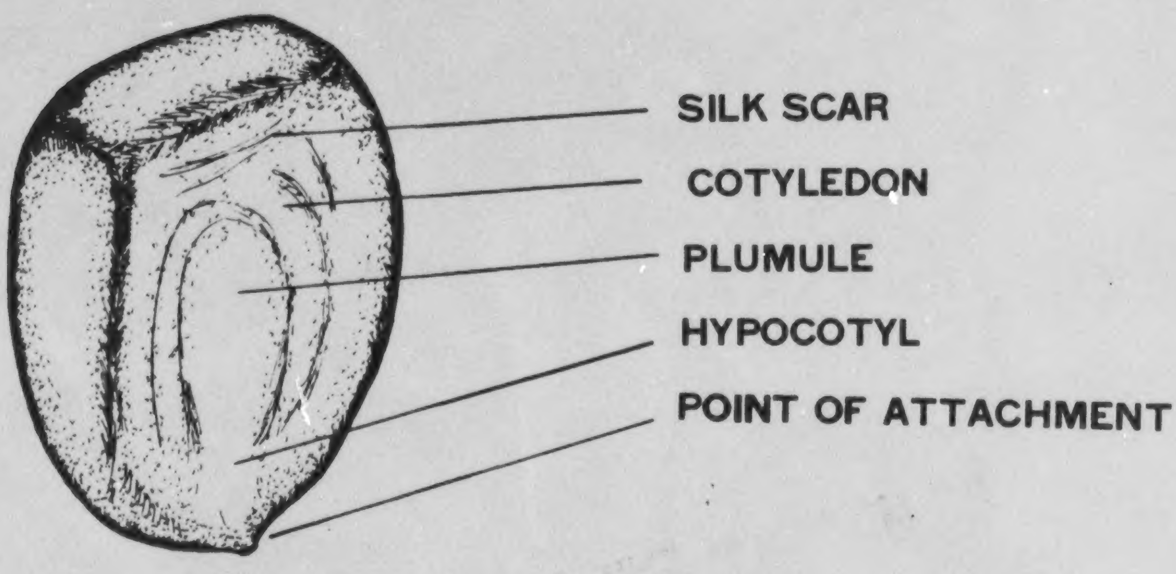
STEPS IN THE GERMINATION OF A BEAN SEED


TERMINAL BUD
FIRST TRUE LEAVES
COTYLEDON
EPICOTYL
PLUMULE
HYPOCOTYL
HYPOCOTYL
TESTA
(seed coat)

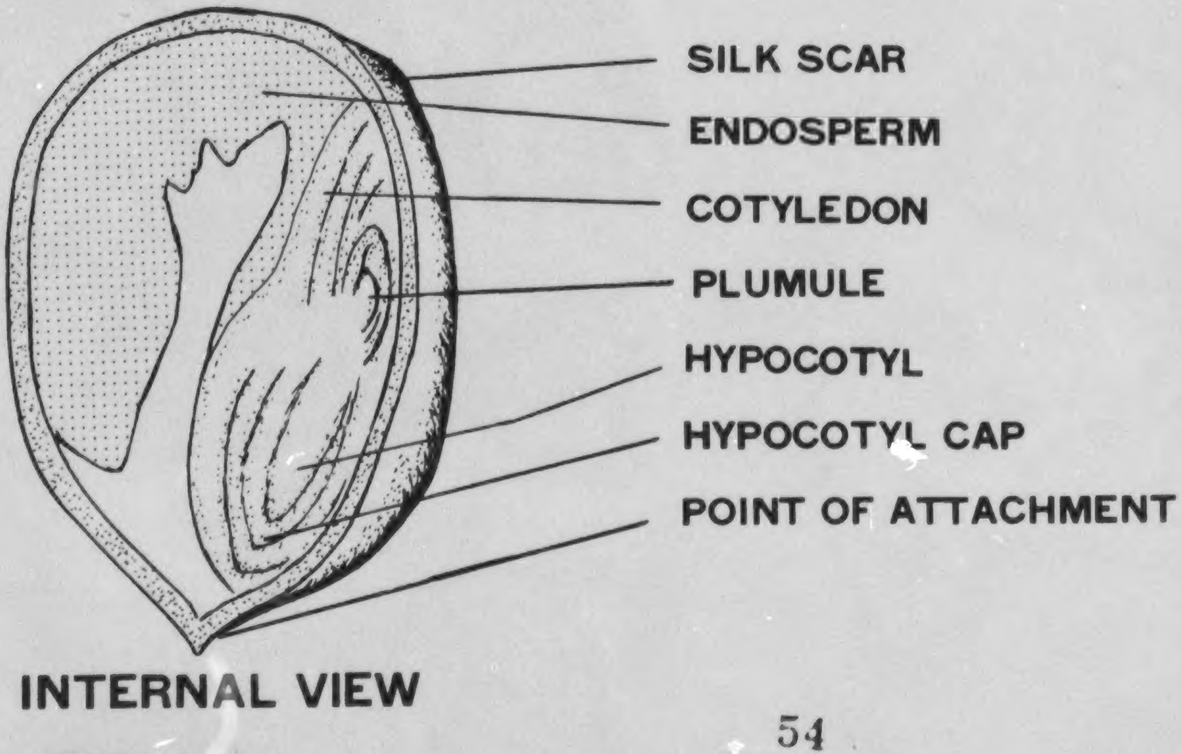
COMPARISON OF DICOTYLEDONOUS AND MONOCOTYLEDONOUS SEEDS

BEAN	CORN
HAS TESTA WITH HILUM. AND MICROPYLE (OPENING IN SEED) PLAINLY VISIBLE	HILUM (SEED ATTACHMENT SCAR) COVERED BY FRUIT COATS
TWO COTYLEDONS (SEED LEAVES)	ONE COTYLEDON (SEED LEAF)
LARGE EMBRYO	SMALL EMBRYO
NO SEPARATE ENDOSPERM	LARGE ENDOSPERM
PLUMULE (LEAF OF YOUNG PLANT) FAIRLY LARGE	PLUMULE RATHER SMALL
PLUMULE LEAVES FOLDED	PLUMULE LEAVES ROLLED
THE FRUIT A POD, WITH MANY SEEDS	THE FRUIT IS A SINGLE GRAIN, WITH ONE SEED

STRUCTURE OF A CORN SEED (MONOCOTYLEDONOUS)

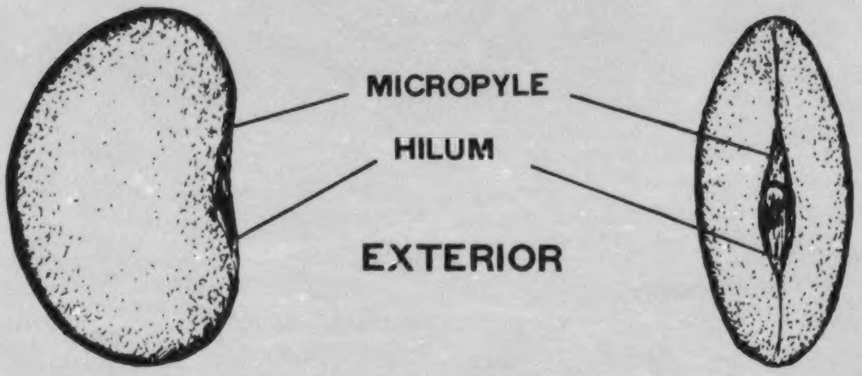

SILK SCAR
COTYLEDON
PLUMULE
HYPOCOTYL
POINT OF ATTACHMENT

EXTERNAL VIEW

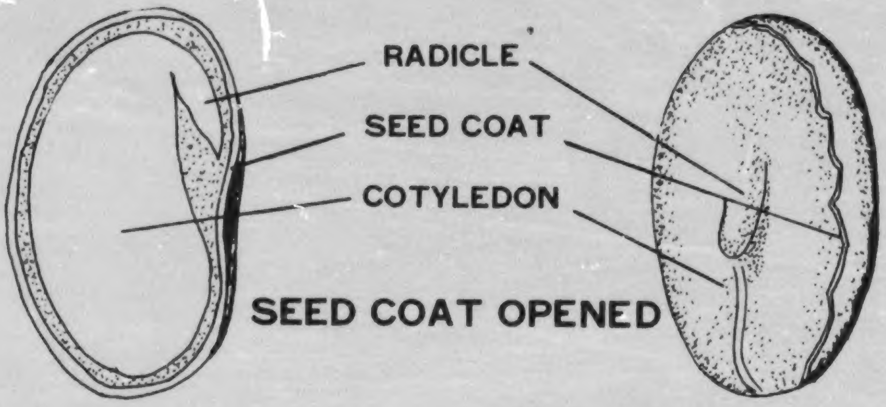

SILK SCAR
ENDOSPERM
COTYLEDON
PLUMULE
HYPOCOTYL
HYPOCOTYL CAP
POINT OF ATTACHMENT

INTERNAL VIEW

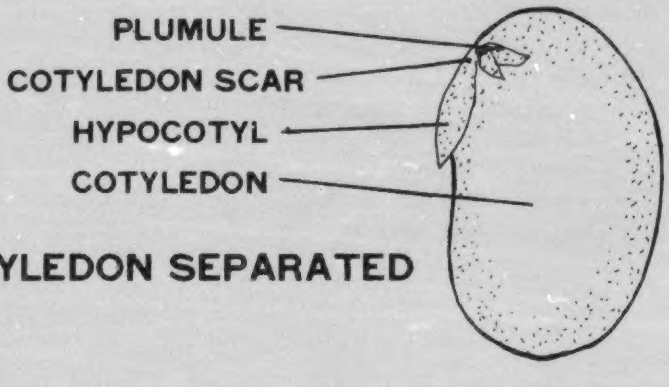
STRUCTURE OF A BEAN SEED
(DICOTYLEDONOUS)


MICROPYLE
HILUM

EXTERIOR

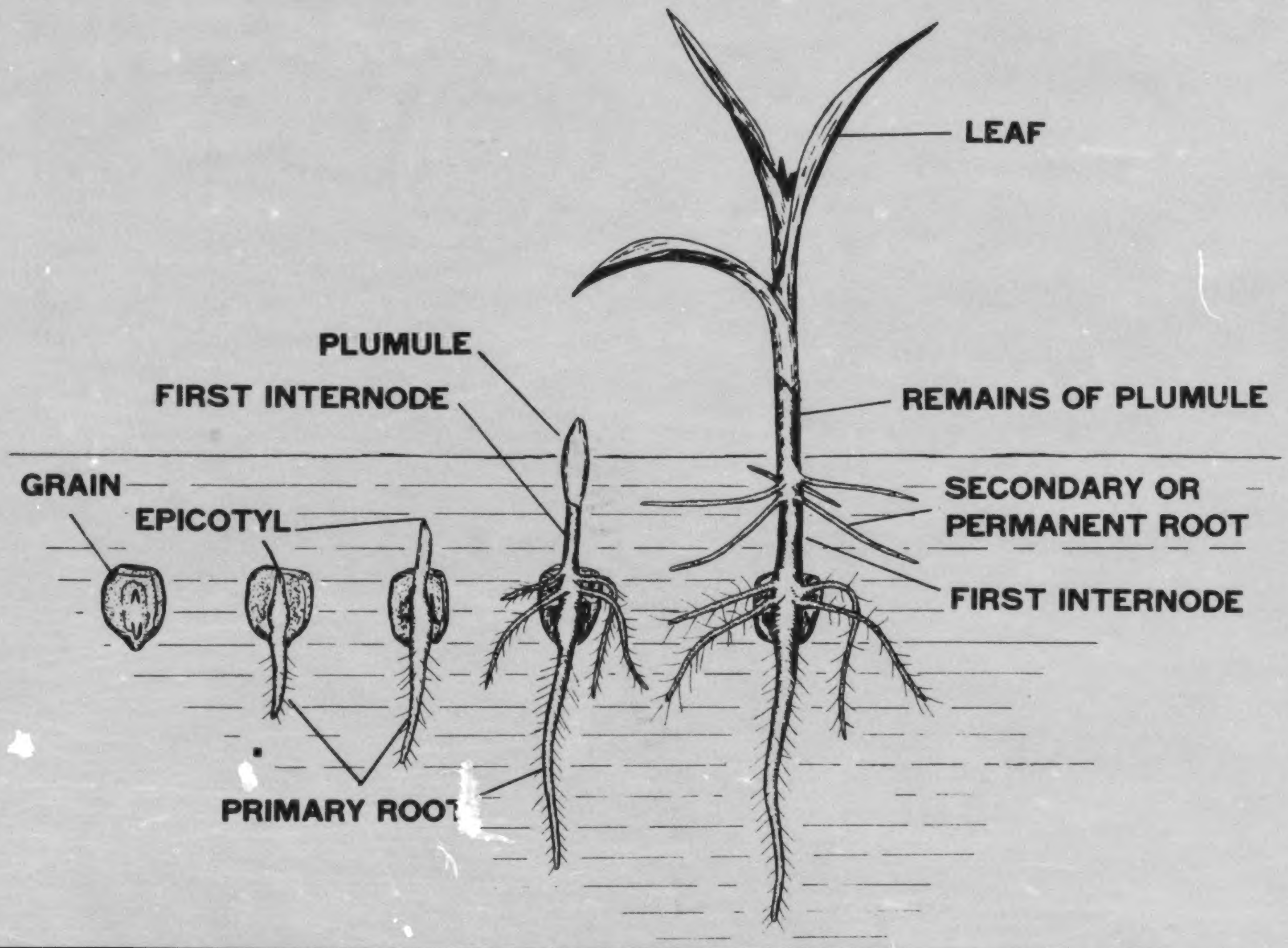

RADICLE
SEED COAT
COTYLEDON

SEED COAT OPENED


PLUMULE
COTYLEDON SCAR
HYPOCOTYL
COTYLEDON

COTYLEDON SEPARATED

STEPS IN THE GERMINATION OF A CORN SEED


LEAF
PLUMULE
FIRST INTERNODE
REMAINS OF PLUMULE
GRAIN
EPICOTYL
SECONDARY OR
PERMANENT ROOT
FIRST INTERNODE
PRIMARY ROOT

PLANT SCIENCE

Unit B: Plant Growth

Topic 3: How Plants Make, Use, and Store Food

Suggestions and Activities: Transparencies can be made from photosynthesis, leaf parts, respiration, and transpiration information. Photosynthesis and transpiration experiments may be conducted as class laboratories.

1. Photosynthesis - A Plant Food Making Process

After the tiny crop plant emerges and enters the seedling stage, it soon ceases to be dependent upon food provided by the seed. The young seedling becomes self supporting by manufacturing its own food from certain raw materials.

The young plant may be thought of as a factory, with all its auxiliary systems of transporting, processing, and distributing materials. Materials enter the factory as raw products. These materials are processed to provide the needs of the plant itself, and also to provide man and animal with food and fiber.

a. The Meaning of Photosynthesis - Photosynthesis is the process by which carbohydrates are formed in the chlorophyll - containing tissues of plants exposed to light. ("Photo" means light, and "synthesis" means putting together.) A more appropriate definition - the process whereby certain living plant cells combine carbon dioxide, water, and light in the presence of chlorophyll and certain enzymes to form carbohydrates - mostly glucose, a simple sugar, and to release oxygen.

Transparencies Nos. 1 and 2

b. Raw Materials Changed to Carbohydrates - The raw materials (carbon dioxide, water, and mineral compounds) are converted into carbohydrates primarily in the leaves.

The leaves of a plant are considered the place where materials are transformed or manufactured into a form of food that is either used or stored by the plant; therefore, they are the main parts of a plant where photosynthesis takes place.

The important parts of a leaf and their functions are:

Part	Function
Cuticle	A waxy protective covering on external part of plant. Protects the plant.
Lower Epidermis	Cell layer on one side of leaf interspersed with stomata. Permits exchange of CO_2 with H_2O.
Upper Epidermis	Prevents loss of water
Palisade Cells	Food making, rich in Chloroplasts (colored chlorophyll cells)
Spongy Layer	Food making, area for gaseous exchange and transpiration
Chloroplasts	Green solid body that contains colored Chlorophyll - enables food making
Air Spaces	Transports air and water vapor
Stomata	Openings (pores) admitting and releasing CO_2 and O_2 giving off H_2O
Veins	Transport water and foodstuffs - give leaf support

Transparencies Nos. 3 and 4

c. The Method by Which Photosynthesis Takes Place

Carbon dioxide (CO_2) is taken in by the leaves through small openings (stomata) which are in the outer layer of the leaf cells (epidermis). The stomata guard cells close when photosynthesis ceases. This condition takes place during darkness.

Carbon dioxide combines with water (H_2O) and forms a simple carbohydrate. The water and minerals are absorbed from the soil by roots and carried up the stem's xylem tubes to the leaves. The combination of CO_2 and H_2O is caused by the energy of light working through a complex system of enzymes.

Chemical changes that take place in forming plant food are:

$$6CO_2 + 12H_2O + \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

$$\text{Carbon dioxide} + \text{Water} + \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Sugar} + \text{Water} + \text{Oxygen}$$

Twelve molecules of water are used in photosynthesis.

Six molecules of water are produced. (not derived from process)

Six molecules of oxygen derived from splitting water molecules.

The oxygen in the glucose (sugar) is derived from splitting the CO_2 molecules.

Sugars (fructose, sucrose, maltose), starches, and cellulose are other organic materials that can be produced in photosynthesis.

The two types of chlorophyll found in crop plants are a and b. Chlorophyll is made up of chemical structures that serve in the chemical reaction which takes place in the photosynthetic process. The color of chlorophyll a is bluish-green and chlorophyll b is yellowish-green. The yellowish-green color may also be a chlorophyll deficiency in plants. The letters a and b are symbols used to identify the different types of chlorophyll.

Light energy is necessary for photosynthesis, but starch may be changed to sugar during the non-daylight hours of each day; therefore, plants used the soluble sugars and continue to grow at night. Number (3) above explains that plants produce and use food sugars for growth during daylight hours.

Transparencies Nos. 4 and 5

d. How Nutrients and Water are Absorbed and Distributed

Absorption -

Diffusion - Carbon dioxide, a gas, is taken into the plant through the openings (pores) found on the leaf. The process occurs when CO_2 is needed in the plants. The gas (CO_2) passes from the air - a higher concentration - into the leaf, a lower concentration. The CO_2 entrance is made through the stomatas.

Osmosis - Most of the water enters root hairs (epidermal cell) of plants due to osmosis. The concentration of water is reduced as the plant uses and transpires it; therefore, water moves from a higher concentration through a differentially permeable membrane to a lower concentration, the plant root.

A differentially permeable membrane is one which controls substances as they pass through it. The cells become turgid (swollen) and the plant stands straight - the leaves are crisp when the cells are filled tight with water.

Non-rooting feeding - Under certain conditions some nutrients and water enter plants through leaves and stems. For example, nitrogen is sometimes applied to leaves in the form of a spray.

Distribution

Plant nutrients move from cell to cell by osmosis after they have been absorbed by the root hairs. As nutrients reach the tubes (xylem) that conduct the water to the leaves, they move into the leaves, where carbon dioxide and water is present to produce plant food (sugar) through the process of photosynthesis.

Manufactured food materials are transported from the leaves by a portion of the vascular tubes (phloem), to various parts of the plants where food is converted into carbohydrates, fats, proteins, cellulose, hemicellulose, and lignin (component of the woody part of the fibrovascular bundles in plant tissue). These materials are for the building of new cells or repairing old ones.

2. Use of Food by Plants

Transparencies Nos. 6 and 7

a. Respiration Process - Respiration in plants is chemically reverse to that of photosynthesis. The process is as follows:

There is oxidation of glucose molecules.
Carbon dioxide and water are formed.
Energy is released to the cell.

The result of the process is:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy}$$

Respiration is an organic process. The organic compound $C_6H_{12} + 6O_2$ (sugar) plus $6O_2$ (oxygen) is broken down releasing energy, carbon dioxide, and water.

Importance of Respiration

About 25 percent of the sugar manufactured in plant leaves is used for plant energy to conduct life processes.

Respiration is a continuous process - 24 hours per day; photosynthesis ceases during the night. CO_2 is released at night and O_2 is released during the day.

Moisture and temperature are the two main factors that affect respiration. The effect of respiration can be easily observed in stored seed with a high moisture content and in poorly cured hay.

High moisture content (end product of respiration) and warm temperature increase the rate of respiration for stored crops.

Generally, plants respire and photosynthesize faster during warm temperature. Warm days and cool nights are better for the small grain filling period and tuber developing period. There is less respiration during cool nights and warm days than during hot nights and warm days.

b. Transpiration or Evaporation of Moisture - Water vapor loss by the plant occurs mainly through the leaves. This loss of water is called transpiration. Most of the water vapor escapes through the stomata but it may take place on any part not covered by a cuticle or cork layer.

By diffusion water enters the plant through the walls of the root hairs, passing to the xylem tubes and up the stem to the leaves and other parts of the plant where a small amount is used in the process of photosynthesis and the remainder evaporates into the air.

The value of water to the plant

Cools the plant leaves
Provides raw materials used in the photosynthesis process
Serves as a medium for transporting nutrients from the soil to plant parts
Gives the plant rigidity by keeping the cells expanded
Conducts manufactured food from the leaves to all parts of the plant

Water requirements vary according to the crop plant. To produce one pound of dry alfalfa it will take about 850 pounds of water. Only about 370 pounds of water are required to produce one pound (dry matter) of corn.

The wilting of plants can be caused either by the movement of water in reverse (the water moves out of the root into soils that are high in soluble salts) or the roots failing to absorb water as fast as it is evaporated through the leaves.

The amount of water lost by transpiration varies due to the following factors:

Climatic conditions extracting water from the leaves

The number of the stomata and the size of the pores on the leaves

Leaf water capacity

Availability of soil moisture to the plant

General plant structure limiting transpiration - thickened cuticle, waxy covering, sunken stomata, and reduced leaf surface. When water is limited the stomata guard cells may wilt.

Transpiration is greater for plants in fertile soils than poor soils; therefore, the plant uses more water on fertile soils than poor soils.

c. Uses of Plant Foods - Plant foods are used mainly for energy and growth. The part of food made by photosynthesis must be burned for energy to make the other processes function. Plant foods are carbohydrates, fats, and protein.

Carbohydrates are composed of carbon, hydrogen, and oxygen. Carbohydrates make up nearly all of the total weight of the plant. For example, 500 pounds of lint cotton contains 425 pounds of carbohydrates, and 1000 pounds of cottonseed contains 263 pounds of carbohydrates. They are sources of plant energy.

Fats are also carbon, hydrogen, and oxygen, but the element proportions are different than in the carbohydrates. They are sources of plant energy. Crop seed oils become solids when the melting points are raised (hydrogenated).

Proteins are from 75 to 85 percent carbon, hydrogen, and oxygen. They also contain nitrogen and sulphur, and they may contain phosphorus. Proteins are used in plant cell production.

Digestion and Assimilation in Plants

Digestion is the changing of starch, fats, and proteins into a soluble form for plant use.

Assimilation is the conversion of carbohydrates, fats, and protein and simpler nitrogenous foods into living material (protoplasm).

3. How Plants Store Food

a. Food storage by plant class

Annuals (plants that live only one year) store food in the form of seed. Corn, wheat, oats, and beans and many others fit into this class.

Biennials live two years producing seed the second year. They usually store food in the roots the first year. Clovers, sugar beets, and turnips are in the biennial class.

Perennials store food in seed, roots, stems, and other parts of the plant. For example, Johnson grass, Irish potato, and asparagus store food in underground stems. Food is stored in the roots of alfalfa. Orchard grass stores food in the crown bud. Perennials are plants that live from year to year.

b. Storage of surplus food in other plants

Leaves - cabbage
Petioles or leaves - celery
Stems and leaves - onion
Floral parts - broccoli
Buds - brusselssprouts
Ovary wall and contents - green beans
Receptacle of flower - apple

c. Type of food stored in field crops

Starch is the most abundant food stored by plants. It is found in great quantities in grains and tubers.

Fats and proteins are found in soybeans, cottonseed, flaxseed, and peanuts. There are also other plants rich in protein and oil.

References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall Inc., Englewood Cliffs, NJ, 1967.

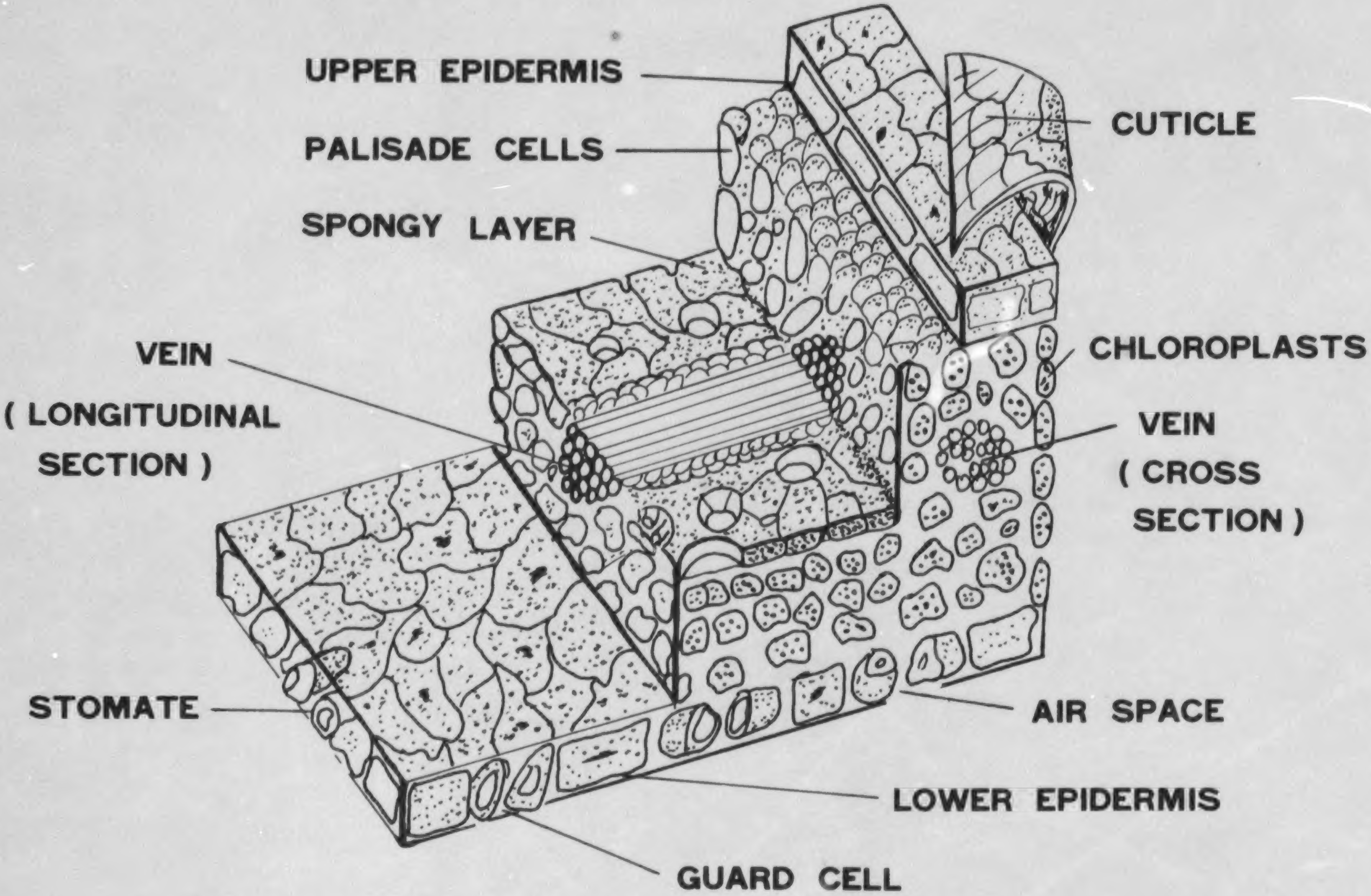
2. Hughes, Harold D. and others, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1967.

3. Klingman, Glenn C., Crop Production in the South, John Wiley and Sons, Inc., New York, NY, 1967.

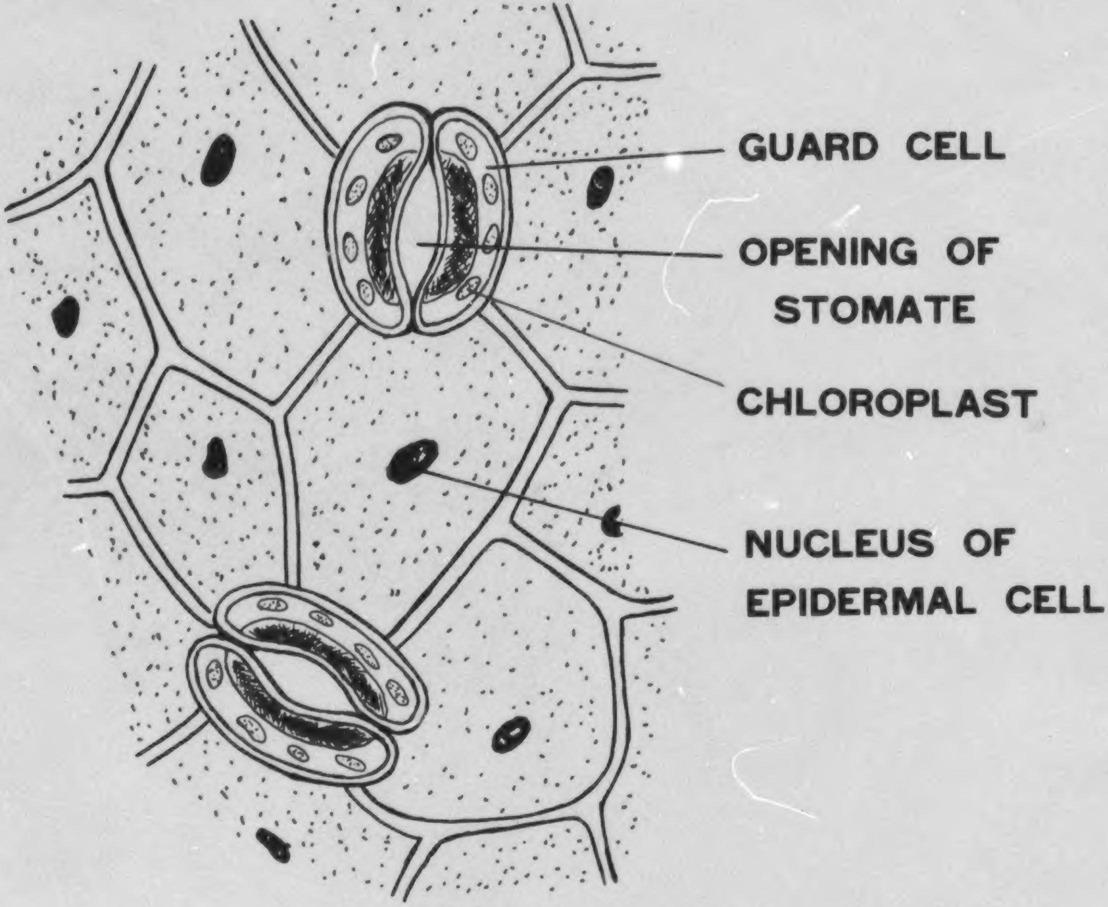
4. Martin, John H. and Wareen H. Leonard, Principles of Field Crops Production, The Macmillan Company, New York, NY, 1969.

5. Plant Science, State Department of Education, Agricultural Education, University of Missouri, Columbia, MO, 1967

CROSS SECTION OF A LEAF


UPPER EPIDERMIS
PALISADE CELLS
SPONGY LAYER
CUTICLE
VEIN
(LONGITUDINAL SECTION)
CHLOROPLASTS
VEIN
(CROSS SECTION)
STOMATE
AIR SPACE
LOWER EPIDERMIS
GUARD CELL

LOWER EPIDERMIS OF A LEAF


GUARD CELL
OPENING OF STOMATE
CHLOROPLAST
NUCLEUS OF EPIDERMAL CELL

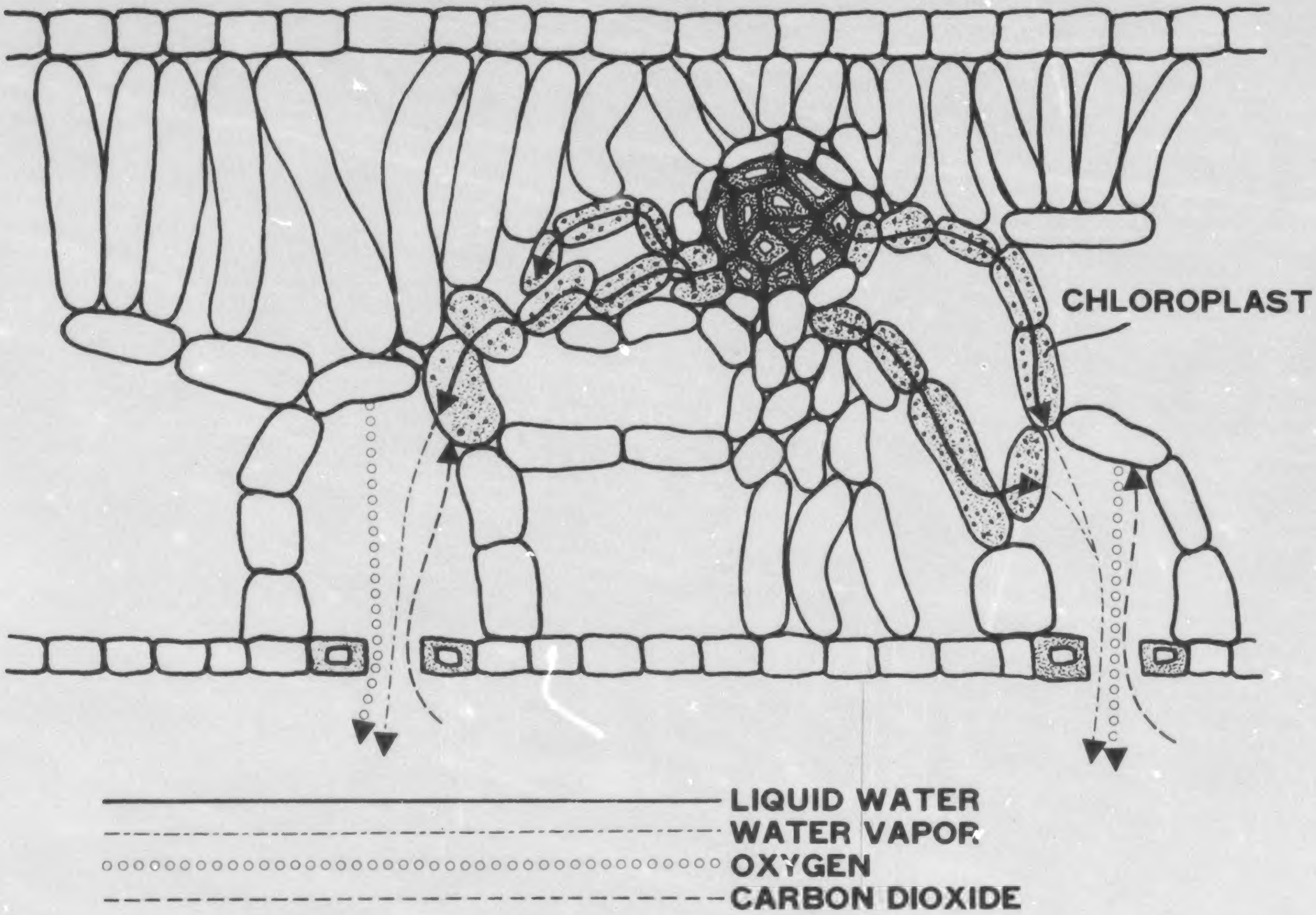
PHOTOSYNTHESIS

THE CHEMICAL CHANGES THAT TAKE PLACE IN FORMING PLANT FOOD ARE:

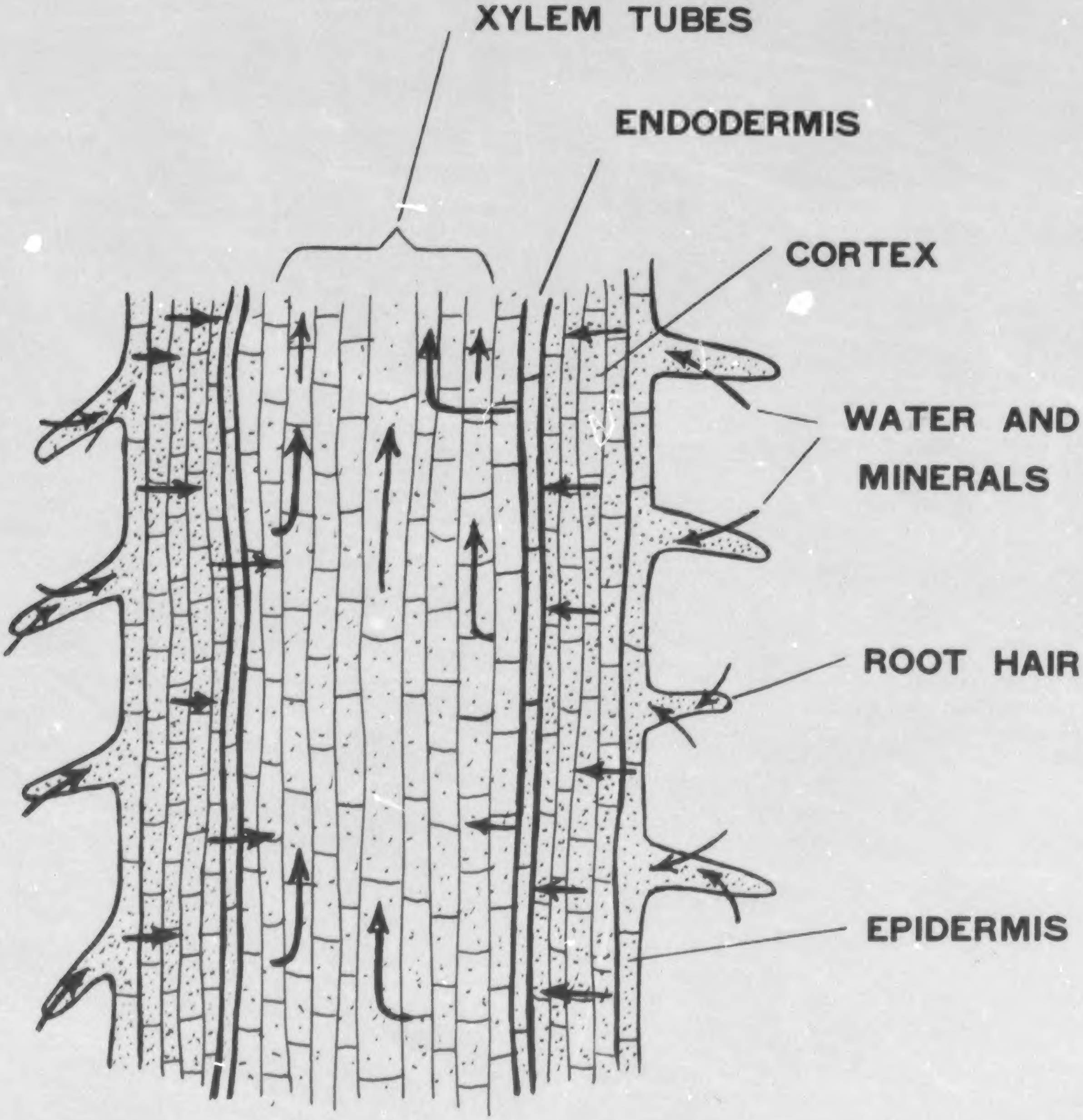
$$6CO_2 + 12H_2O + \xrightarrow[\text{CHLOROPHYLL}]{\text{LIGHT}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

$$\text{CARBON DIOXIDE} + \text{WATER} + \xrightarrow[\text{CHLOROPHYLL}]{\text{LIGHT}} \text{SUGAR} + \text{WATER} + \text{OXYGEN}$$

MOVEMENT OF WATER & GASES IN LEAF DURING PHOTOSYNTHESIS


CHLOROPLAST
LIQUID WATER
WATER VAPOR
OXYGEN
CARBON DIOXIDE

WATER MOVEMENT FROM SOIL THROUGH ROOT


XYLEM TUBES
ENDODERMIS
CORTEX
WATER AND MINERALS
ROOT HAIR
EPIDERMIS

RESPIRATION IS OPPOSITE OF PHOTOSYNTHESIS

PHOTOSYNTHESIS	RESPIRATION
A BUILDING PROCESS	A DESTRUCTION PROCESS
FOOD MANUFACTURED	FOOD CONSUMED
SUN PROVIDES ENERGY	ENERGY IS RELEASED
CO_2 TAKEN IN PLANT	CO_2 GIVEN OFF
OXYGEN GIVEN OFF	OXYGEN USED
COMPLEX COMPOUNDS FORM	SIMPLE COMPOUNDS FORM
PRODUCES SUGARS, STARCHES	PRODUCES CO_2 & H_2O
REQUIRES LIGHT	GOES ON DAY AND NIGHT
CHLOROPHYLL MUST BE PRESENT	CARRIED ON IN ALL CELLS

RESPIRATION

RELEASE OF ENERGY REQUIRED BY THE PLANT

PROCESS

OXIDATION OF PLANT SUGAR (GLUCOSE) MOLECULES

FORMATION OF CARBON DIOXIDE, WATER AND ENERGY

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O + \text{ENERGY}$$

PLANT SCIENCE

Unit C: Identification and Selection of Plants - Field Crops

Topic 1: Classification of Plants - Field Crops

Suggested Procedure and Activities: Transparencies can be made from the various plant classifications.

1. The Importance of Grouping Plants According to Botanical Classification

The study of naming and classifying plants is called taxonomy. The botanical classification of plants is an aid to the taxonomist, agronomist, and agriculturalist in understanding and remembering plants by the similarities and differences found in the structure of their different parts.

There are about 300,000 species of plants that have been identified and classified. Approximately 155,000 species of plants are in the dicotyledon division.

The botanical names of plants is a universal language. The plant names are based upon Latin descriptions and must be approved by a Congress, or Committee, of plant scientists. Carl Linnaeus, a Swedish botanist, developed the present system of plant classification in 1753.

If there are no botanical classification to identify and classify plants, many different species would carry one common name. For example, all clovers would be identified as clover even though crimson clover is a winter annual and sweet clover is a biennial.

Transparency No. 1

2. The Botanical Classification of Corn and Alfalfa Plants

Common Name:	Corn
Kingdom:	Plant
Phylum:	Spermatophyta (seed plants)
Subphylum:	Angiosperm (seed in fruit)
Class:	Monocotyledona (single leaf seed)
Order:	Graminales (grass like families)
Family:	Gramineae (grass family)
Genus:	Zea (the corns)
Species:	Mays (dent corns)
Variety:	Reid's yellow dent

Common Name:	Alfalfa
Kingdom:	Plant
Phylum:	Spermatophyta (seed plant)
Subphylum:	Angiosperm
Class:	Dicotyledona (two leaf seed)
Order:	Fosales
Family:	Leguminoseae
Genus:	Medicago
Species:	Sativa
Variety:	Ranger

3. The Four Divisions of the Plant Kindgom

a. The four large phyla in the plant kingdom are:

Thallophytes or thallus plants (algae, fungi, and bacteria) -- plants having no stems, roots, and leaves.

Algae are green scums found growing on ponds. They contain chlorophyll.

Fungi are plants that do not contain chlorophyll. Fungi is both beneficial and harmful. These simple non-green plants include: molds, mildews, yeasts, mushrooms, smuts, and ringworm fungi. They are needed for preservation of beverages and curing of cheese and are considered beneficial to man and animal.

Bacteria are harmful and beneficial. The type that lives on plant nodules and takes nitrogen from the air is beneficial. Other bacteria liberate plant nutrients by rotting plant refuse. Bacteria are microscopic one-cell plants.

Bryophytes include liverworts and mosses. They do not produce flowers or seed and have no leaves or stems. They are not of economic importance in crop production.

Pteridophytes are ferns, horsetails, and club mosses. Like the liverworts and mosses, they are of no economic importance to the crop producer.

Spermatophytes produce seed or fruit after fertilization takes place in the flowers. They are the most specialized and important plant to man and animal in the plant kingdom; therefore, this division includes the field crops.

4. Divisions of Seed-Producing Plants Which are Known as Spermatophytes

a. After being divided into phyla, plants are further divided into classes. Spermatophytes are classed as gymnosperms and angiosperms (subphylum).

Gymnosperms produce seed not enclosed in an ovary; therefore, they are naked seed. They are considered woody perennial forms which are usually evergreen plants such as pine, fir, spruce, and others.

The angiosperms include all the flowering plants. They are of greatest importance to agriculture because they include the cultivated crops. Their flower produces the fruit, or ovary, in which the seeds are enclosed.

b. The angiosperms are divided into monocotyledonous and dicotyledonous classes.

The word "mono" means one and "cotyledon" means seed-leaf. Monocot is substituted for monocotyledon and dicot for dicotyledon. A monocot has one seed-leaf,and a dicot has two seed leaves.

Monocots include the grass family, or gramineae, which includes all the cereal crops and three-fourths of the cultivated forage crops.

Dicots include the legume family, or leguminoseae. They produce their seed in a pod or compartment.

5. A List of the Most Important Seed-Producing Plant Families (with examples) Classified Under the Monocotyledon and Dicotyledon Divisions

Transparency No. 2

a. Monocotyledon

Grass family (gramineae)
Corn, wheat, barley, rye, oats, and other cereal grains; grasses and millets.

Lily family (liliceae)
Lilies, onions, tulips, wild onions, and wild garlic.

b. Dicotyledon

Legume family (leguminoseae)
Beans, peas, peanuts, vetch, alfalfa, clovers, lespedezas, soybeans, and other kudzu.

Nightshade family (solanaceae)
White potatoes, tobacco, pepper, egg plant, and ground cherries.

Mustard family (cruciferae)
Turnips, kale, rutabaga, cabbage, cauliflower, Brussels sprouts, radish, water cress, and mustard.

Morning glory family (convolvulaceae)
Morning glory, sweet potato, and dodder

Mallow family (Malvaceae)
Cotton and okra

Rose family (rosaceae)
Rose, peach, almond, apricot, pear, apple, plum, and strawberry

6. Binomial System Used in Classifying Plants

a. When identifying a plant by its scientific name, it is not necessary to give its entire classification.

b. A specific crop plant can be identified by using the genus and species. For example, grain sorghum is sorghum (genus) vulgare (species).

c. Generally speaking, species corresponds to the person's first name and genus to a person's last name.

d. Species are broken down into varieties. Things to remember about varieties are as follows:

Varieties are developed by man; other classifications are not.

Variety is a rank within a species.

Variety is distinguished by capital name before the species name (Triumph wheat).

7. Plant Part Characteristics

Seed - Producing Plants

a.	Monocot	Dicot
Transparency No. 2		
Seed	Cotyledon - one seed leaf.	Cotyledons - two seed leaves.
	Not divided into two parts.	Divided into two conspicuous parts (cotyledons).

	Monocot	Dicot
	Most of seed interior is floury endosperm (young plant food).	Some have black scar (hilum) and minute hole near hilum (microphyle). Hilum is scar of seed attachment. Micropyle is opening for pollen tube.
Transparency No. 3		
Leaves	Consist of two parts, the sheath that envelops the stem and the blade.	Alternate on the stems.
	Usually found in two alternate rows on the stem and attached at the node.	Netted-veined with either prominent central midrib or single midrib. Veins branch out from midrib.
	Main veins parallel each other.	Simple leaf-blade of one piece. Compound leaf-many lobes (leaflets) that join at base of stalk (petiole).
	In some monocots leaves have auricles (claw-like growth of the leaf around node) and a ligule (tissue-like projection located between the sheath and stem where the leaf and stem join).	Leaflets are usually rounded, and are either smooth or hairy.
		Leaflike appendages (stipules) are found at the base of the stalk.
Transparency No. 4		
Roots	Lacks a principal root. Many fibrous roots of about same size. Never has nodules. Fibrous adventitious roots.	Has a large primary root (tap root) with secondary roots. Usually has nodules, especially if in the legume family.
Transparency No. 5		

	Monocot	Dicot
Flowers	Flower parts -- petals and sepals are usually arranged in threes.	Flower parts -- petals and sepals and usually other parts are arranged in twos, fours, and mostly numbers of fives. Stamens and carpels (stigma, style and ovary) are identified.
	In the grass family they are in a compact or open inflorescence (the flowering part of the plant).	Are butterfly-like in field crop legumes.
Transparency No. 6		
Stems	Either hollow or pithy cylindrical stems made up of nodes and internodes.	Lacking distinct nodes usually with pithy stem.
	Vascular bundles are usually scattered (lacking definite arrangement in the stem).	Vascular bundles arranged in a ring or circle in the stem.

8. Classification of Field Crops According to Use

a. Cereal Crops - Cereal crops are grown to furnish edible seed. They are considered grasses. Seven of the more important crops are: corn, wheat, rice, grain sorghum, barley, oats, and rye.

b. Seed Legumes - The most important legumes grown for their edible seed are: soybeans, peanuts, field beans, field peas, and cowpeas.

c. Forage Crops - Grasses and legumes that are grown as feed for animals are considered to be forage crops. The feed may be in the form of silage, pasture, harvested hay, and fodder. Grass forage crops are: corn, sorghum, alfalfa, oats, barley, hay grasses, and clovers.

d. Root Crops - Sweet potatoes, rutabagas, beets, and turnips are the most common root crops grown as food and feed.

e. Fiber Crops - Raw materials for producing textiles, rope, and twine are produced from cotton, flax, and hemp. Cotton has always been recognized as the most important fiber plant.

f. Sugar Crops - Sugar plants include sugar beets, sugar cane, and the sweet sorghums. Sugar cane and sugar beets furnish the bulk of sugar and syrup produced in the United States. Sweet sorghum and corn are used to produce syrup.

g. Oil Crops - Cottonseed, soybeans, flax, peanuts, and castor beans are the most important crops grown to produce oils for human consumption and commercial use.

h. Tuber Crops - Irish potatoes are thickened underground stems. It is a tuber of importance in the United States. The Jerusalem artichoke is also a tuber.

i. Stimulant Crops - The most important stimulant crops are tobacco, coffee, and tea. Tobacco is the most important stimulant crop in the United States.

j. Fruit, Vegetable, and Timber Crops - These three crops are not referred to as field crops, but they are considered major crops in certain areas.

9. Special Use Classification

a. Green Manure Crops - Crops included in this group are: clovers, vetches, cowpeas, soybeans, and other crops. The crops are plowed under green for the purpose of making the soil more productive.

b. Cover Crops - Crops that are planted to protect the soil are crimson clover, rye, vetch, seasonal grasses, and, in some areas, buckwheat.

c. Emergency Crops - Crops planted in the place where crops have failed are known as catch or emergency crops. They are usually quick growing crops used for feed or green manure. Sudan grass, rye, and millet are examples of catch crops.

d. Soiling Crops - Crops that are usually cut green and fed to livestock without curing are sorghums, alfalfa, corn, and soybeans.

e. Silage Crops - Corn and sorghums are generally used for silage, but other crops such as soybeans, cowpeas, clovers, grasses, and sunflowers are used. The crop is preserved in a succulent condition by passing through a stage of partial fermentation.

f. Companion Crops - Grasses, clovers, peas, and beans are often sown with other crops.

10. Thermo Classification

a. Warm Season Crops - Crops requiring warm climates are grown in the southern half of the United States. They are found in the subtropical crop belt, cotton belt, and the southern part of the grazing and irrigated crops region. Tropical crop plants produce where freezing seldom occurs.

Examples are: Cotton, tobacco, field peas, sorghums, and citrus fruits.

b. Cool Season Crops - Crops requiring warm climates are grown in the northern half of the United States. They are found in the wheat belts, corn belt, and hay and dairy regions. Many cool season crops require winter weather for maximum growth and flowering.

Examples are: Most cereals and tubers and certain fruit (apples) crops.

11. Life Span Classification

Another method used in grouping plants (field crops) is on the basis of their growth characteristics.

The botanical classification of plants is probably the most important method used for identifying and grouping of all known plants. The binomial system which is made up of the genus and species identified the plant scientifically.

a. Annuals are plants that complete their life cycles in one year. Annuals are propagated from seed. They mature, produce seed, and die in a single season.

Summer annuals such as corn, beans, peas, and sorghum are planted in the spring; they mature, produce seed , and die before fall.

Winter annuals such as winter wheat, winter peas, and vetch are planted in the fall and the plant dies after the seed is produced in the summer.

b. Biennials live two seasons. The first year they produce vegetative parts and store food. The stored food is used the second year for growth and seed production. After the seed is produced the plant dies.

Examples of biennials are sweet clover, cabbage, beets, and carrots.

c. Perennials are plants that live more than two seasons. Most perennials develop the first season but do not produce flowers until the following season or later.

Perennial crops are white clover, bermudagrasses, Sericea lespedeza, and many others.

Cotton will grow as a perennial if the climatic conditions permit. If warm weather continues throughout a winter season in certain areas of the United States a second crop of cotton can be produced from stumps of the first crop.

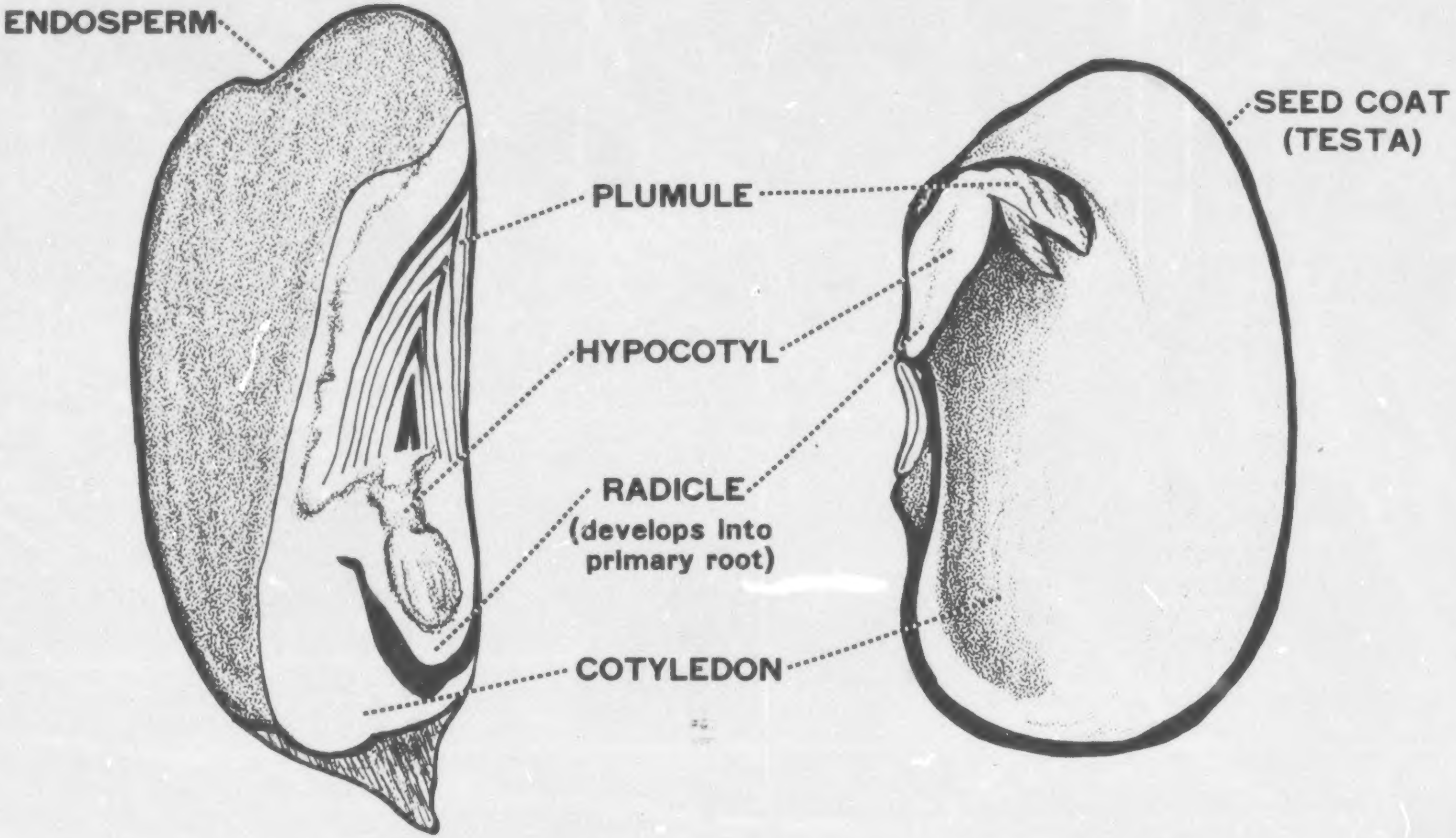
References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.
2. Hughes, Harold D. and others, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1967.
3. Janick, Jules and others, Plant Science: An Introduction to World Crops, W. H. Freeman and Company, San Francisco, CA, 1969.
4. Klingham, Glenn, Crop Production in the South, John Wiley and Sons, Inc., New York, NY, 1967.
5. Martin, John H. and Warren H. Leonard, Principles of Field Crop Production, The Macmillan Company, New York, NY, 1965.

BOTANICAL CLASSIFICATION OF CORN

COMMON NAME	CORN
KINGDOM	PLANT
PHYLUM	SPERMATOPHYTA (SEED PLANTS)
SUBPHYLUM	ANGIOSPERMA
CLASS	MONOCOTYLEDONA
ORDER	GRAMINALES
FAMILY	GRAMINEAE (GRASS PLANTS)
GENUS	ZEA
SPECIES	MAYS
VARIETY	REID'S YELLOW DENT

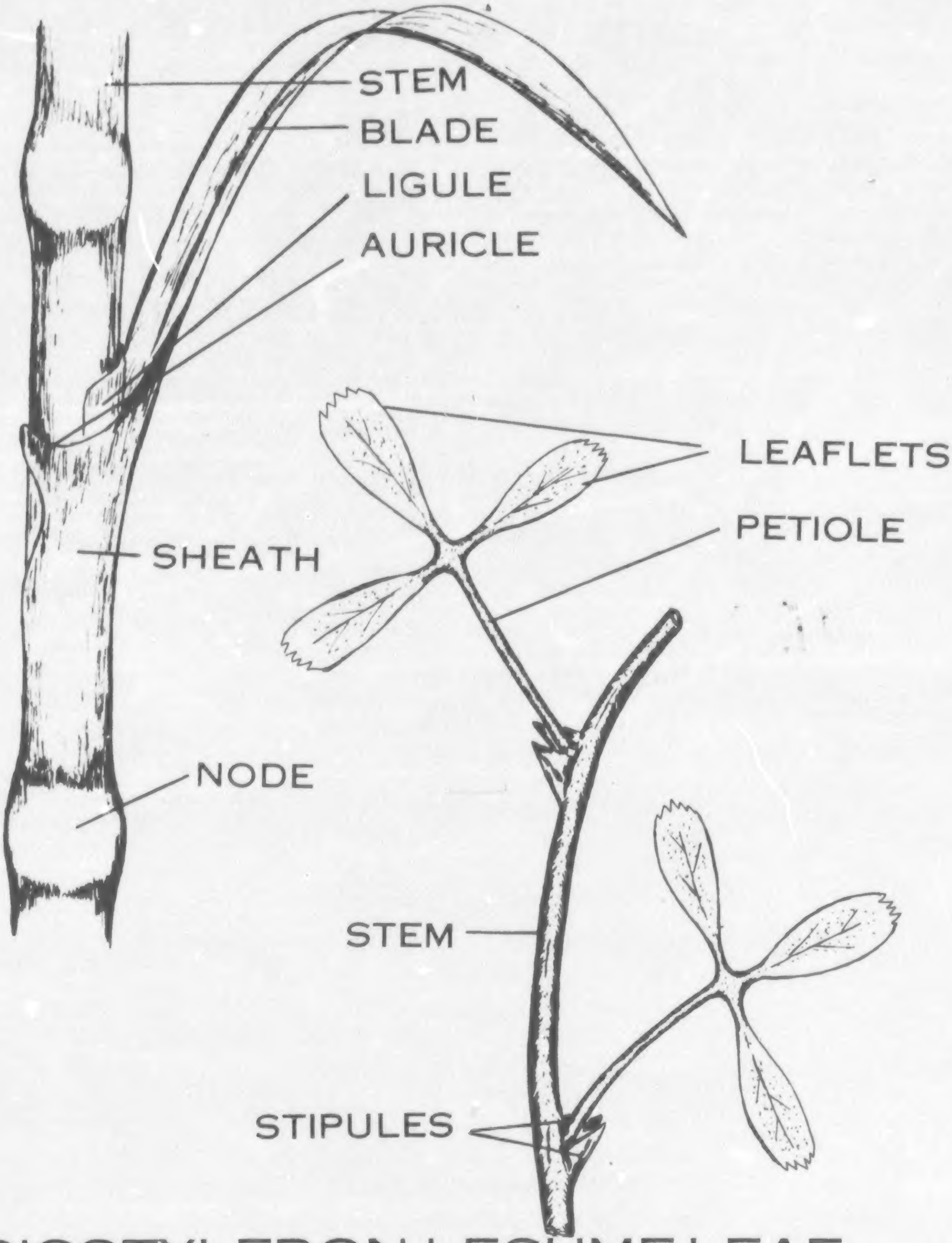
BINOMIAL CLASSIFICATION


ENDOSPERM
SEED COAT (TESTA)
PLUMULE
HYPOCOTYL
RADICLE (develops into primary root)
COTYLEDON

MONOCOTYLEDON (CORN)

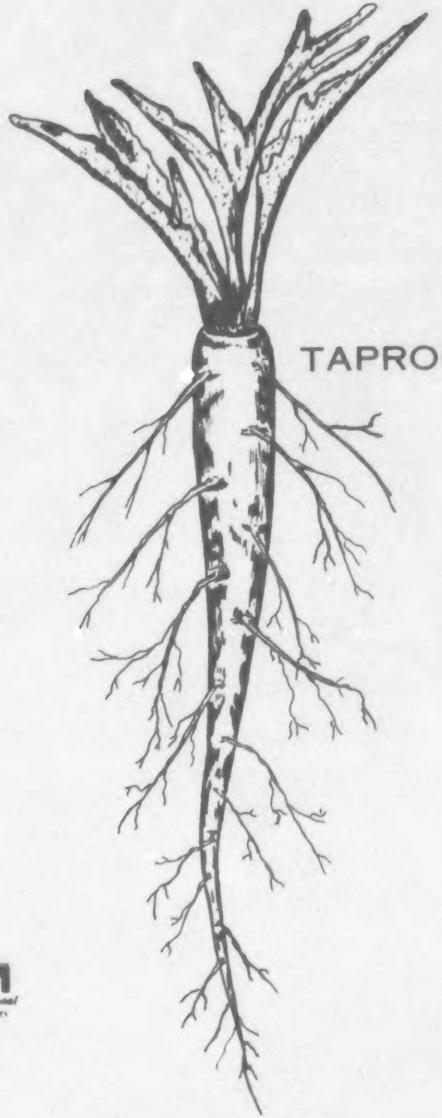
DICOTYLEDON (BEAN)

MONOCOTYLEDON-GRASS LEAF

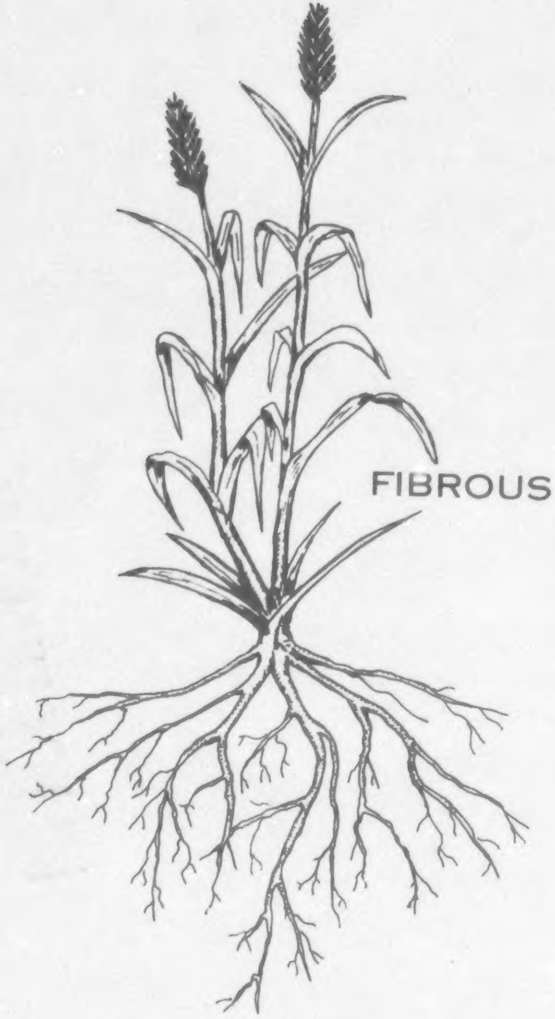

STEM
BLADE
LIGULE
AURICLE
SHEATH
NODE
LEAFLETS
PETIOLE
STEM
STIPULES

DICOTYLEDON-LEGUME LEAF

ROOT SYSTEMS

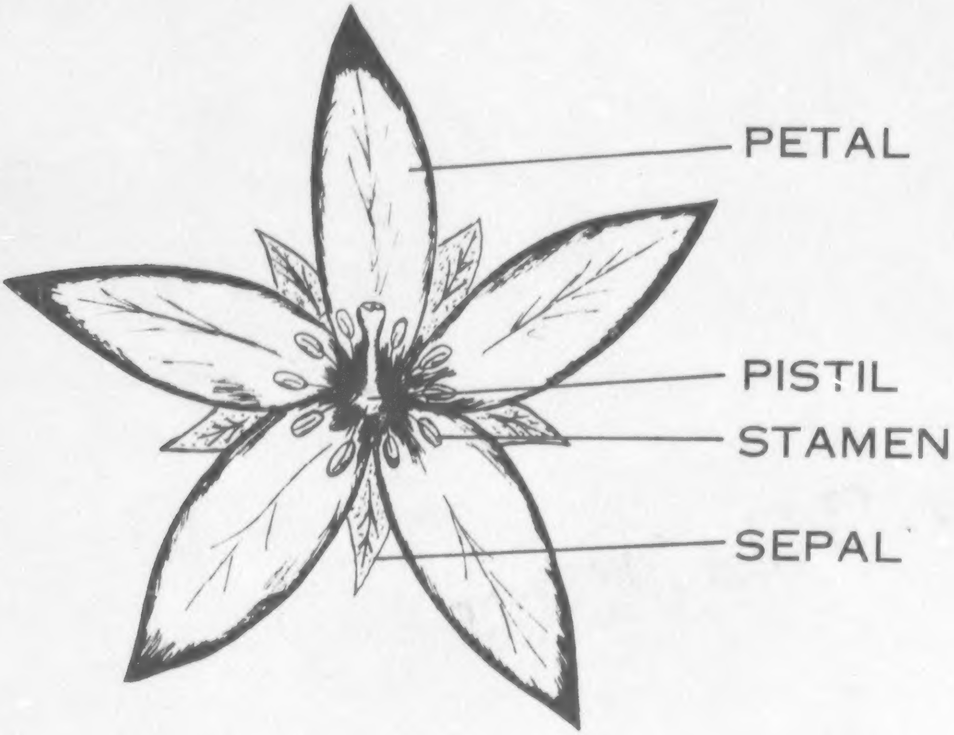


TAPROOT SYSTEM

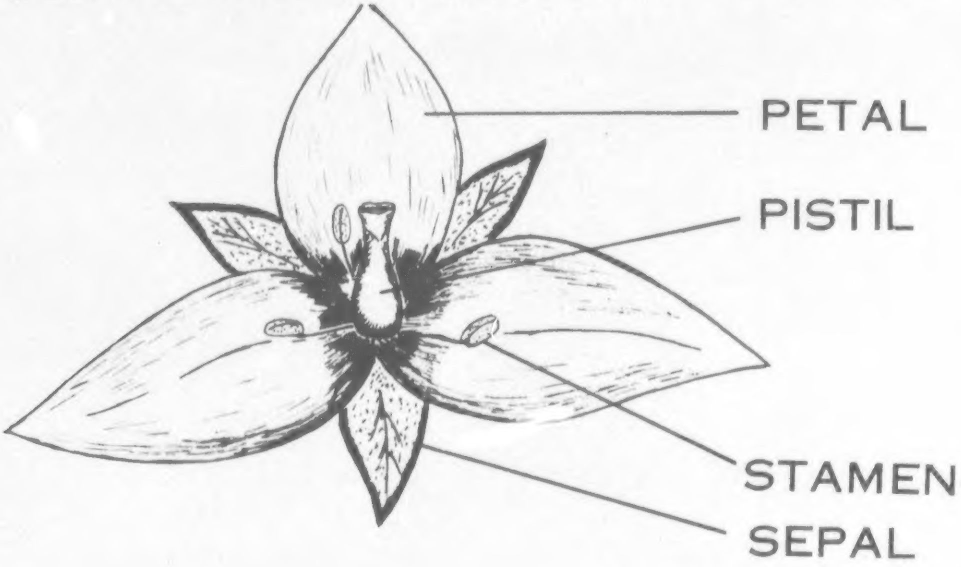


FIBROUS SYSTEM

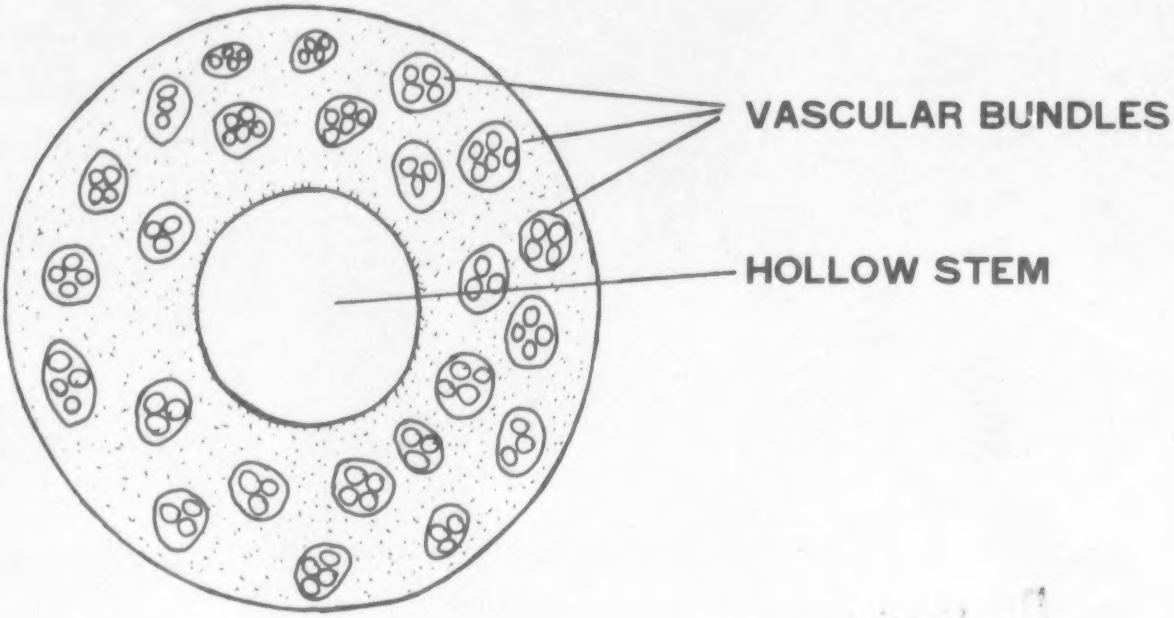
DICOTYLEDON FLOWER


PETAL
PISTIL
STAMEN
SEPAL

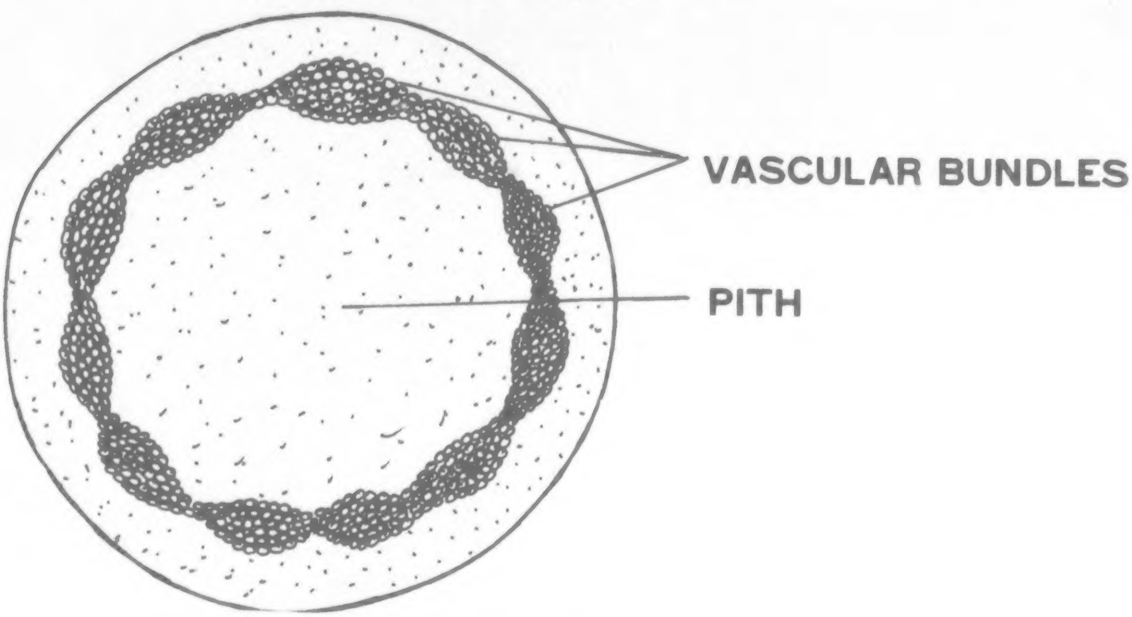
MONOCOTYLEDON FLOWER


PETAL
PISTIL
STAMEN
SEPAL

MONOCOTYLEDON STEM


VASCULAR BUNDLES
HOLLOW STEM

DICOTYLEDON STEM


VASCULAR BUNDLES
PITH

PLANT SCIENCE

Unit C: Identification and Selection of Plants - Field Crops

Topic 2: Selection of Plants - Field Crops

Suggested Procedure and Activities: The two transparencies can be presented at the beginning of the lesson. An exhibit of seed and lint cotton varieties may add to the lesson discussion.

Transparency No. 1

1. Early Methods of Introducing Crops

   a. Introduction of crops from other countries

Most of the staple field crops used in the United States today were introduced from other parts of the world. An exception is the field bean.

When our forefathers came to this country they brought varieties of plant seed and plants to assist in supplying their basic foods.

A division of the United States Department of Agriculture, the Bureau of Plant Industry, has introduced the majority of all imported crop varieties since 1889.

Some important crops from other countries:
Cotton - Mexico and Asia
Corn - Mexico, Central and South America
Tobacco, tomatoes, and peanuts - South America
Rice, alfalfa, and soybeans - Asia (rice-India) (soybeans-China)
Field peas, oats, clover, and common vetch - Europe
Wheat - Asia Minor (Turkey, Saudi Arabia)
Barley - Asia and Ethiopia

Crop improvement began with primitive man. Many tribes and races of people have lived on one type of grain along with other crops. For example, the Aztec, Mayan, and Inca Indians of Mexico, Central America, and South America were dependent upon corn as a basic cereal crop.

   b. Early crop selection methods used by agriculturists

Different strains and types of crops were developed by the early agriculturists. Crops were selected according to need and general use and their adaptability to various climatic conditions. For example, the American Indian selected and stored seed corn. The corn grown by the Indian at the beginning of the sixteenth century compared in quality to the corn that was grown by the American settler about 1850.

Crop selection was first introduced according to need.

A portion of the seed was withheld after harvest for the following season's planting. In some cases cotton, peas, beans, and sorghum seed were selected from plants that were favored with a good environment. Corn was selected according to the size of ear and fullness of grain.

In most cases no field selection was made. The planting seed was selected from the storage bin. Seeds that were abnormal in shape were extracted and only the well developed seed was planted.

Transparency No. 2

2. Important Factors Affecting the Choice of Crops

   a. Crop Use and Market - Is the crop or a portion of the crop to be used as food or feed at home? Is there a market for the crop? There must be a demand for the crop being produced. For example, vegetables should be grown where there are packing plants and wholesale markets.

   b. Climate - Is the crop adapted to the local climatic conditions? How will the temperature, rainfall, humidity, and wind affect the crop? Some varieties produce more than others in some areas where climate is a production factor. A freeze causes some cool season plants to be more productive. Subtropical plants cannot withstand a freeze.

   c. Soil - What type of soil is best suited for the crop? Does the crop require a clay, sand, or silt soil? Is the crop adaptable to an acid or alkaline soil? Can the crop be grown best on a shallow soil or a deep soil? It is recognized that soil is one of the most important factors in choosing a crop. Does the soil respond to certain types of fertilizers?

   d. Labor, Machinery and Equipment - Are labor and equipment available to produce and harvest the crop? Hired hand labor and available custom equipment may affect the decision on choosing a crop, especially if the crop is perishable immediately after ripening or pest control is needed throughout the growing season.

   e. Available Acreage - Can the proper amount of land be procured to justify the crop? Small grain production will require a large acreage, whereas vegetable production may require a small acreage.

f. Insects and Diseases - What control practices are necessary to grow the crop? Is the crop resistant to certain insects and/or diseases? For example, Acala cotton 1517 WR is resistant to verticillium wilt (a disease caused by a fungus that attacks the plant root). Researchers are working on the development of a cotton plant with pigments that will be resistant to the boll worm.

g. Maturity and Strength of Plant - If the crop is a cool weather plant, will it mature and produce fruit during hot summer months? If it is a warm weather annual, will it reach maturity before the average frost date in the fall? For example, certain cotton varieties may mature in 95 days, whereas other varieties require 120 days to mature. An important factor in selecting small grains is their resistance to lodging.

h. Quality of Product - The market is based upon the quality of raw materials. Crops are sold according to quality. Why shouldn't the producers select a variety that has quality? For example, if both Lone Star and Acala cotton varieties are adapted to the locality, yet Acala produces 1/8 inch longer fiber, which variety should be selected?

i. Size of Plant and Yield - The producer's net income is based upon two factors: quality and quantity. Yield varies with variety; therefore, the producer selects a crop that is a high producer. If Martins Milo has an average production of 3500 pounds per acre and Plainsman 4000 pounds per acre in the same county, why will the producer select Plainsman?

j. Cost of Production - What net income could be expected from the crop? What phase of production (planting, cultivating, controlling insects and/or diseases, and harvesting) is most expensive? The most expensive phase should be studied to reduce expenses.

3. Two Methods Used in Crop Selection

a. Mass Selection. Mass selection consists of selecting plants with desired characteristics. The seed of these plants are mixed and planted together, then another selection is made which eliminates the weaker or undesirable ones.

Grimm alfalfa, Tennessee Winter barley, and Reid's yellow dent corn are examples of mass selection of field crops. Grimm alfalfa and Tennessee Winter barley were developed through mass selection for winter hardness.

Open-Pollinated corn was selected in the fields and corn cribs for many years. The result of the mass selection method was more uniformity in ears and seed and the filling of tips and butts of ears.

b. Pedigree Selection. Pedigree selection is referred to as pure line and individual selection. Individual plants are selected and their performance is recorded on a record.

Seed for the individual plant is planted in an individual plant row. Self-fertilization and cross-fertilization can be used in this method.

Performance records can plot characteristics such as growth, yield, fruit quality, disease and insect resistance, and lodging. In each selection the best plants are chosen for seed producers.

c. The main purposes for using mass selection and pedigree selection of plants are:

Plants are improved through proper selection methods. It is a way of improving existing varieties of plants.

New varieties are developed through the two selection methods.

4. Plants are Selected for Use According to Type

Field crops are also classed according to groups or types. The group or type is determined mainly by the characteristics of the fruit and the general characteristics of the plant.

For example, dent corn comprises 95 percent of all corn grown in the United States. It is partially identified by the shrinking of soft starch found in the crown end of the kernel as it ripens. It has also a very starchy endosperm (the starchy part of the seed).

The selection of type depends largely upon the utility value or need for the whole plant, its fruit, or both plant and fruit.

a. Types of Corn

Dent corn is grown for livestock feed and cereals.

Sweet corn is usually harvested as human food before maturity. When mature, the kernels are very wrinkled.

Flour corn or soft corn has an endosperm composed of soft starch. The kernels are smooth. It is one of the most popular corns among American Indian tribes.

Popcorn is identified by a small ear containing a hard flinty type of starch in the small kernel. It is used for human consumption.

Flint corn kernels are composed of a hard starch. Flint corn is resistant to the weevil, it makes good corn meal, and it is good livestock feed when the kernels are ground.

Pod corn is not considered of commercial importance in the United States. It is believed to be a primitive corn.

b. Types of Sorghums

Grain sorghums are used for grain, hay, and silage.

Forage sorghums are used for silage, hay, and pasture.

Sugar and syrup type sorghums are used for hay, silage, pasture, and syrup.

Dual-purpose sorghums -- grain and forage types are used for grain, hay, silage, and pasture.

c. Types of Wheat

Common wheat is used mainly to make flour. About 95 percent of all wheat grown in the United States is of the common species.

Durum wheat is considered to have the hardest grain of all wheats. It is resistant to drought and black stem rust. This wheat is not suitable for bread flour, but it is used for macaroni and spaghetti.

Club wheat is of minor importance in the United States. It is used for making pastry flour and for exporting purposes.

Poulard, Einkorn, Emmer, Polish, and Spelt types of wheat are not grown extensively in the United States.

d. Types of Barley

Six-row is the most common type of barley grown in the United States. It is used for making malt and feed.

Two-row barley is not an important barley crop in the United States. It is preferred in Europe for malting purposes.

Two-row and six-row refers to the number of rows of grain on the head of barley.

e. Types of Oats

Common oats are grown for feed and pasture. White oats are the most common in this group.

Cultivated red oats are also an important grain and pasture plant, but they are grown only in the south.

f. Types of Rice

Short-grain is grown in California, and it consists of Japanese varieties.

Medium-grain is grown in Louisiana, Texas, and Arkansas.

Long-grain is also grown in Texas, Louisiana, and Arkansas.

All rice is used for food. In many areas rice is selected according to maturity time, production, lodging, and demand. Long-grain may have a higher grain breaking percent when milled than the other two types.

g. Types of Cotton

Upland cotton varieties comprise most of the annual cotton crop in the United States. The staple ranges from short to long (3/4 to 1-1/2 inches).

Sea Island and American-Egyptian (Pima) cotton is grown mostly in three states. Sea Island is found in Georgia and Florida, and American-Egyptian is found in Arizona.

5. Some Common Varieties of Corn, Sorghum, Wheat, Barley, Oats, Rice, and Cotton Grown in Texas

a. Corn - Over 1,000 varieties of corn are grown in the United States.

Open-pollinated varieties are:
  - Surecropper (white)
  - Ferguson yellow Dent
  - Mexican June
  - Hastings and Thompson Prolific
  - Country Genetleman, Crosby, Stowell's Evergreen, and Honey June (sweet corn)
  - White Rice, Jap Hulless, and Supergold (popcorn)

Corn Hybrids
  - Texas 28, 30, 34, 36, and 17W
  - Purdue 39, Purdue 51, Purgold, and Carmel Cross (sweet corn)
  - Purdue 31, K 4, and Purdue 38 (popcorn)

b. Sorghums

Grain Sorghum

Milo-sooner, Double Dwarf, Caprock, Martin's Plainsman, and Redbine.
Kafir - Blackhull, Red, Dwarf, Combine, and Kafir 60.
Feterita - Standard, Spur, and Dwarf
Hybrid-Texas 660, Texas 601, Texas 611, Texas 620, DeKalb C44a, and RS 590.
Durra (Egyptian Corn) - White, Brown, and Dwarf.

Sweet Sorghum (Sorgo)

Sumac, Honey, Atlas, and Black Amber.
Hybrids - Beef builder and silage king.

Grass Sorghums

Piper sudan, Wheeler Sudan, and Sweet Sudan S. A., 372.

c. Wheat - Blackhull, Tascosa, Milam, Ponca, Bison, Concho, Crockett, and Quanah are wheat varieties found in Texas.

d. Barley - Wintex, Kearney, Reno, Texas, Rodgers, Goliad, Tunis, Harlume, and Ward are varieties recommended for Texas barley regions.

e. Oats - New Nortex, Alamo-X, Bronco, Radar I, Victorgrain, Cimarron, Wintok, Mustang, Moregrain, and Surgrain, Alamo, Ferguson 922, and Frazier are varieties grown in Texas.

f. Rice

Short grain varieties - Caloro and Asahi

Medium grain varieties - Magnolia, Zenith, and Nato

Long grain varieties - Bluebonnet 50, Sunbonnet, Texas Patna, Bluebelle, Belle Patna, Improved Bluebonnet, Toro, TP 49, and Century Pàtna 231.

g. Cotton

In 1910 there were 613 varieties of cotton listed in Tyler's report. "Cotton Varieties Planted 1962-1966," a U. S. D. A. publication, reported about 40 varieties planted.

Immediately after World War II about 50 percent of the cotton acreage in the United States was devoted to the strains (plants derived from a variety) from the six following varieties:

Mebane, Acala, Stoneville 2 B, Coker 100, Half and Half, and Deltapine.

Texas Cotton varieties with a number of strains developed from each variety:

Half and Half - Hibred and Stormproof.

Lone Star - Lankart Sel. 57, Northern Star 4-11, and Wacona.

Mebane - Qualla, Watson, Texas Special, Mebane 141, Bagley, Western Stormproof, and Lockett 140.

Paymaster - Paymaster 54-B and Paymaster 101.

Rowden - Rowden 40, 41A, 41B, and Malone's Rowden.

Acala - Acala 1517, 4042, 1517 BR, Texacala 5455c, California Acala, and Roger's.

Deltapine - Deltapine 14 and 15.

Stoneville - Stoneville 7 and 3202

Other varieties and strains - Coker 100, Austin, Rex, and Delfos 9169.

Sea Island - Seabrook and Seaberry SXP-30.

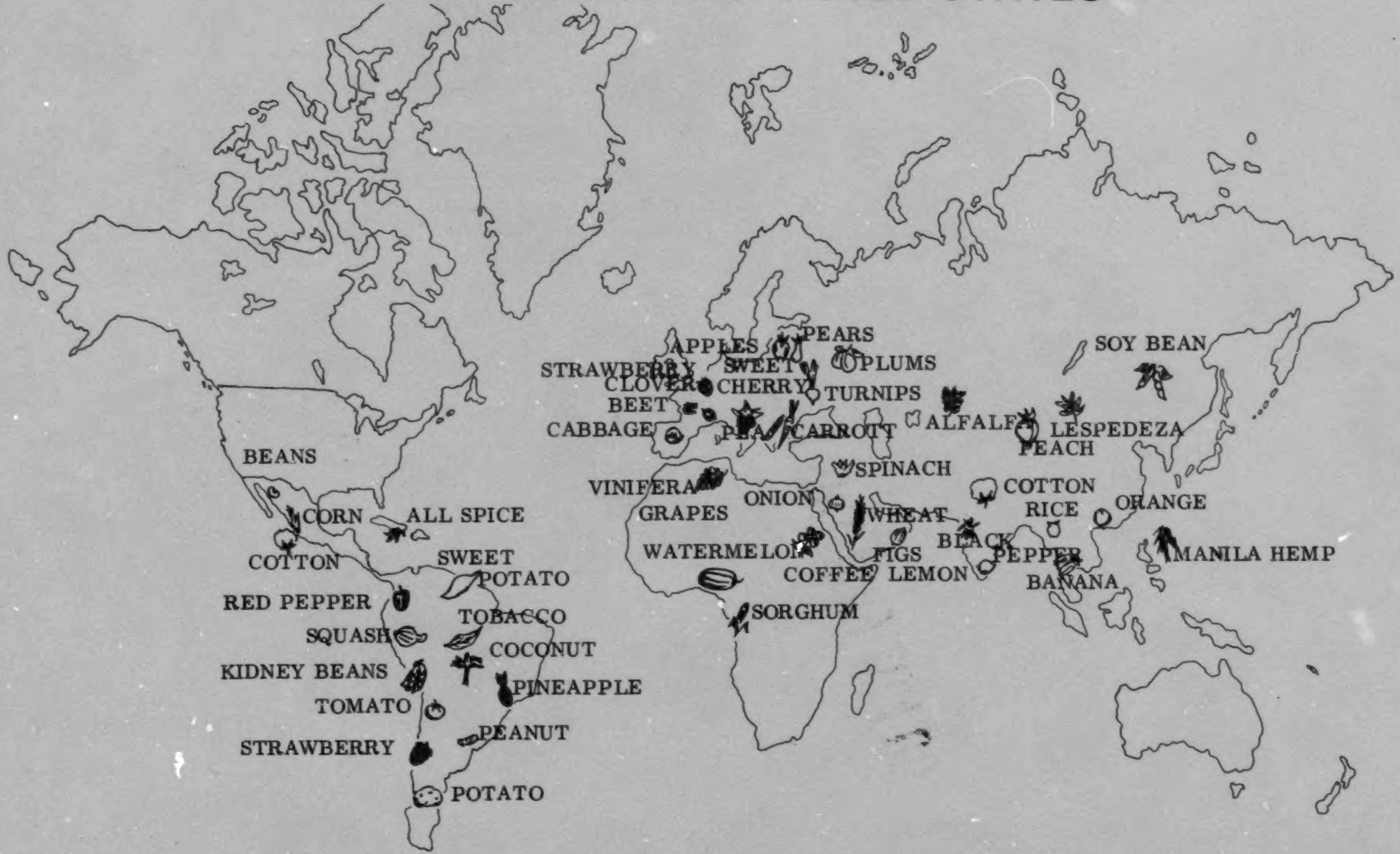
American Egyptian - Pima, SI, Supima, and Earlipima.

Stormresistant - Blightmaster, Stormmaster, Stormking, Stormproof No. 1, and Stormrider.

References:

1. Delorit, Richard J., and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.
2. Elliot, Fred C. and others, Advances in Production and Utilization of Quality Cotton, The Iowa State University Press, Ames, IA, 1968.
3. Hughes, Harold D. and others, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1967.
4. Janick, Jules and Others, Plant Science: An Introduction to World Crops, W. H. Freeman, and Company, San Francisco, CA, 1969.
5. Klingman, Glenn C., Crop Production in the South, John Wiley & Sons, NY, 1967.
6. Mogford, J. S. and others, Crop Production Laboratory Manual, The Exchange Store, Texas A&M University, College Station, TX, 1964.

SOME WORLD CONTRIBUTIONS TO THE CROP PRODUCTION OF THE UNITED STATES


APPLES
PEARS
STRAWBERRY
SWEET
CHERRY
PLUMS
CLOVER
TURNIPS
BEET
CABBAGE
PEA
CARROTT
ALFALFA
LESPEDEZA
PEACH
SOY BEAN
SPINACH
VINIFERA
GRAPES
ONION
COTTON
RICE
ORANGE
WHEAT
BLACK
PEPPER
MANILA HEMP
WATERMELON
FIGS
COFFEE
LEMON
BANANA
SORGHUM
BEANS
CORN
ALL SPICE
COTTON
SWEET
POTATO
RED PEPPER
TOBACCO
SQUASH
COCONUT
KIDNEY BEANS
PINEAPPLE
TOMATO
PEANUT
STRAWBERRY
POTATO

IMPORTANT FACTORS AFFECTING THE CHOICE OF CROPS

CROP USE AND MARKET

CLIMATE

SOIL

LABOR MACHINERY AND EQUIPMENT

AVAILABLE ACREAGE

INSECTS AND DISEASES

MATURITY AND STRENGTH OF PLANT

QUALITY OF PRODUCT

SIZE OF PLANT AND YIELD

PLANT SCIENCE

Unit D: Reproduction

Topic 1: Sexual Plant Production

Suggested Procedure and Activities: Each transparency may be used more than one time while discussing the topic. Live specimens (flowers) can make the subject more effective.

1. The Importance of Plant Reproduction

Most field crops are reproduced from seed; therefore, it is important that agriculturalists learn as much as possible about seed production. Seed crops are very important in the entire world as a basic food for man's diet and a basic feed for the animal's ration. Seed can be transported and stored more easily than other food and feed raw products.

Seed are the end products of sexual reproduction in plants. In this method of reproduction, cross pollination can be performed to make individual plants better adapted to their environment. In other words, sexual propagation makes changes possible.

Plants possess the same heredity characteristic as animals; that is, they reproduce their own kind. The primary functions of the flower and seed are to reproduce the parent plant. A flower exists to produce seed.

Transparency No. 1

2. Essential Reproductive and Floral Parts of a Plant

a. Pistil - The female part of the flower within which egg cells originate. It consists of three parts: stigma, style, and ovary.

Stigma - The uppermost part of the pistil upon which pollen falls and is held.

Style - The part of the pistil that supports the stigma.

Ovary - The lower part of the pistil that produces the ovule or ovules which develop into seed. For example, a bean is an ovule. The ovule is the structure containing the embryo sac in which the egg (female gamete) is found.

b. Stamen - The male part of the flower, consisting of the filament and anther. It is the flower part that produces pollen.

Filament - The stalk of the stamen that supports the anther.

Anther - The pollen bearing part of the stamen. The pollen is dust-like spores that contain the male germ cells of the plant. The male gamete is known as the sperm.

c. Accessory organs of the flower serve to protect the essential organs and to attract insects. These organs are the:

Corolla - The petals of a flower collectively and in the form of modified leaves of a delicate texture and various colors. The petals enclose the pistil inside the calyx. Due to color, odor, and nectar secretion, the petals attract insects.

Calyx - The circle of leaf-like parts called sepals are located below the petals or corolla.

Receptacle - Enlarged and top part of the flower stalk.

Micropyle - Opening for pollen tube to pass into embryo sac.

In some angiosperms the petals and sepals are missing. In others only the petals are missing. The shapes of sepals and petals differ more in the grass flower than most other plant flowers.

3. Types of Flowers

Transparency No. 1

a. Complete flowers have all four parts; sepals, petals, stamens, and pistil. The floral parts are the sepals and petals, and the reproductive parts are the stamens and pistil.

Transparency No. 2

b. Incomplete flowers lack some flower parts. Small grains lack the floral parts, but they are perfect flowers. Other parts of the grass flower are:

Palea - A modified leaf lying next to the main flower parts.

Lodicule - Part at the base of the ovary on grass flowers that forces open the lemma (outer part enclosing the seed) when the anthers are extended.

Transparency No. 2

Perfect flowers have both stamens and pistil. Most field crop plants have perfect flowers.

Transparencies Nos. 3 and 4

Imperfect flowers lack either stamens or pistils. They are divided into two groups, monoecious and dioecious plants.

If the staminate (male) and pistillate (female) flowers are found on the same plant it is said to be monoecious. Flowers of monoecious plants are considered to be cross pollinated, but self pollination can occur. Examples of monoecious plants are: corn, squash, cucumbers, pumpkin, and melon.

Transparency No. 4

Imperfect flowers with the stamens and pistils on different plants (only one sex on the plant) are said to be dioecious. Flowers of dioecious plants must be cross pollinated. Wind and insects are important pollinating agents in the reproduction process of dioecious plants.

4. The Pollination and Fertilization Process

a. Reproduction, or the production of fruit and seed, cannot take place unless there is a successful fusion of the sperm and egg in the embryo sac. That is, the egg cell (female) must be fertilized. After fertilization takes place in the ovary the ovule or seed begins to develop. The egg cell remains in the embryo sac of the pistil during the entire process of fertilization. This type of reproduction is found in the angiosperms or flowering plants which make up the subclasses monocots and dicots.

Transparencies Nos. 3 and 4

b. Pollination takes place when pollen from the anther is transferred to the stigma of the flower. Pollen grains are released by the anther maturing and splitting open.

c. Pollen grains are distributed by various means: gravity, insects, wind, man, animals, humming birds, and several other means.

d. Plants can be grouped according to the way the flower is pollinated.

Self Pollinated - The stigma receives pollen from the anther of the same flower, or pollen is received from other flowers on the same plant. Field crops that are self-pollinated include wheat, beans, barley, tobacco, peas, oats, soybeans, rice, tomatoes, and others.

Often Cross Pollinated - The stigma may receive pollen from the anther in the same flower, from a flower on the same plant, or from a flower of another plant. Cotton, foxtail millet, and sorghum are often cross pollinated. Insects usually cross pollinate cotton, and wind cross pollinates sorghums.

Natural Cross Pollinated - The stigma of a flower in one plant received pollen from the anther of a flower of another plant. Plants of this group are: corn, alfalfa, clover, cabbage, brome grass, and others. Plants that are sterile to their own pollen depend upon insects for cross pollination.

Transparency No. 1

e. Steps involved in fertilization-the pollen nuclei (sperm) unite with ovule nuclei, (egg).

The pollen is anchored on the moist and sticky stigma.

The pollen grain germinates, producing a pollen tube with nucleus which grows down through the style and into the ovary where it reaches the ovule and embryo sac; then it releases two sperm in the tube.

One sperm unites with the egg cell forming the zygote (a cell formed by two gametes, the reproductive cells) which forms the embryo plant by cell division.

The second sperm unites with two separate nuclei to form a primary endosperm nucleus. Double fertilization takes place when one sperm unites with the egg and the second unites with two nuclei.

f. Pollination and fertilization in a monoecious plant, (corn)

Pollen from the male flowers on the tassel are transferred to the pistillate flower (silk).

The pollen grain germinates, sending a pollen tube through the style, or silk, to the ovules, or "blisters", on the cob.

Each blister is an ovary (later a grain) which contains a single ovule. The sperm cell unites with two other cells to form the endosperm or plant food for the young plant to use until photosynthesis takes place. The embryo and endosperm develop within the same seed coat and the mature grain contains both endosperm and embryo. In the bean the embryo absorbs the endosperm; therefore, it is transferred into the cotyledons.

5. General Information About the Corn Plant

As many as 15,000,000 pollen grains may be furnished by flowers on one tassel.

Pollen may not remain viable much longer than one day after leaving the tassle.
After the pollen reaches the stigma, fertilization takes place in about one day (24 hrs.)
Only one pollen grain is needed for the development of each corn kernel.
It is estimated that about 5 percent of the kernels are fertilized by self-pollination.
The pistillate (silk) or female flowers number approximately 800 per plant.

6. Why Plants Fail to Reproduce

a. Reproduction is not likely to occur if something interferes with either pollination or fertilization in the flower of the plant.

b. The following conditions may interfere with reproduction:

Either a freeze or frost may kill the flower or its vital parts (pistil or stamen).

Hard rains may remove the pollen from the flower.

Hot winds may destroy either the stamen or pistils.

Cold temperature may reduce insect activity; therefore, plants requiring insect assistance for cross pollination may be affected due to a lack of pollen.

Harmful insects may destroy the pistils or stamen.

Extremely dry or wet conditions may cause the plant to release flower buds.

References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.

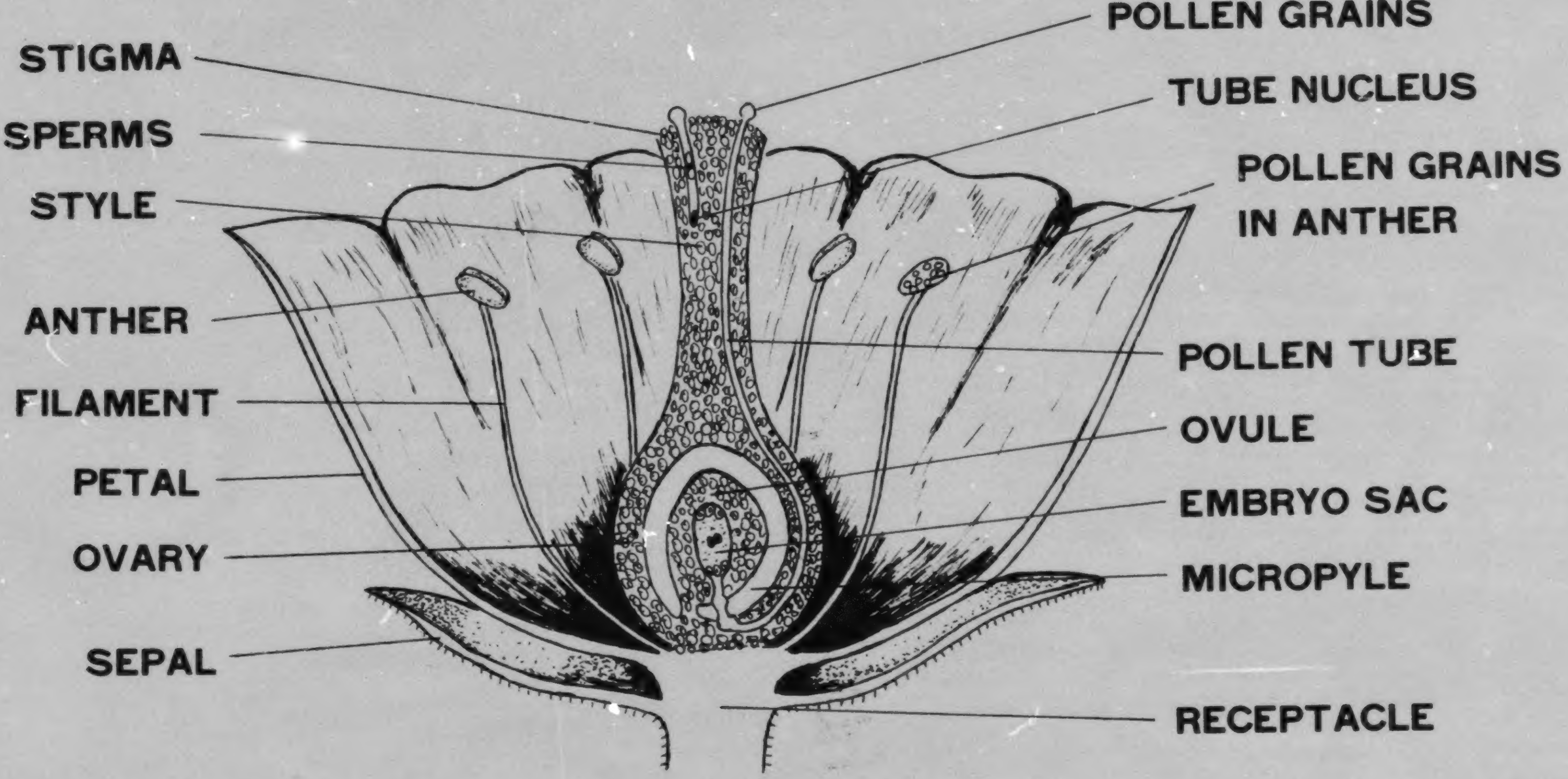
2. Hughes, Harold D. and others, Crop Production Principles and Practices, The Macmillan Company, NY, 1967.

3. Janick, Jules and others, Plant Science: An Introduction to World Crops, W. H. Freeman and Company, San Francisco, CA, 1969.

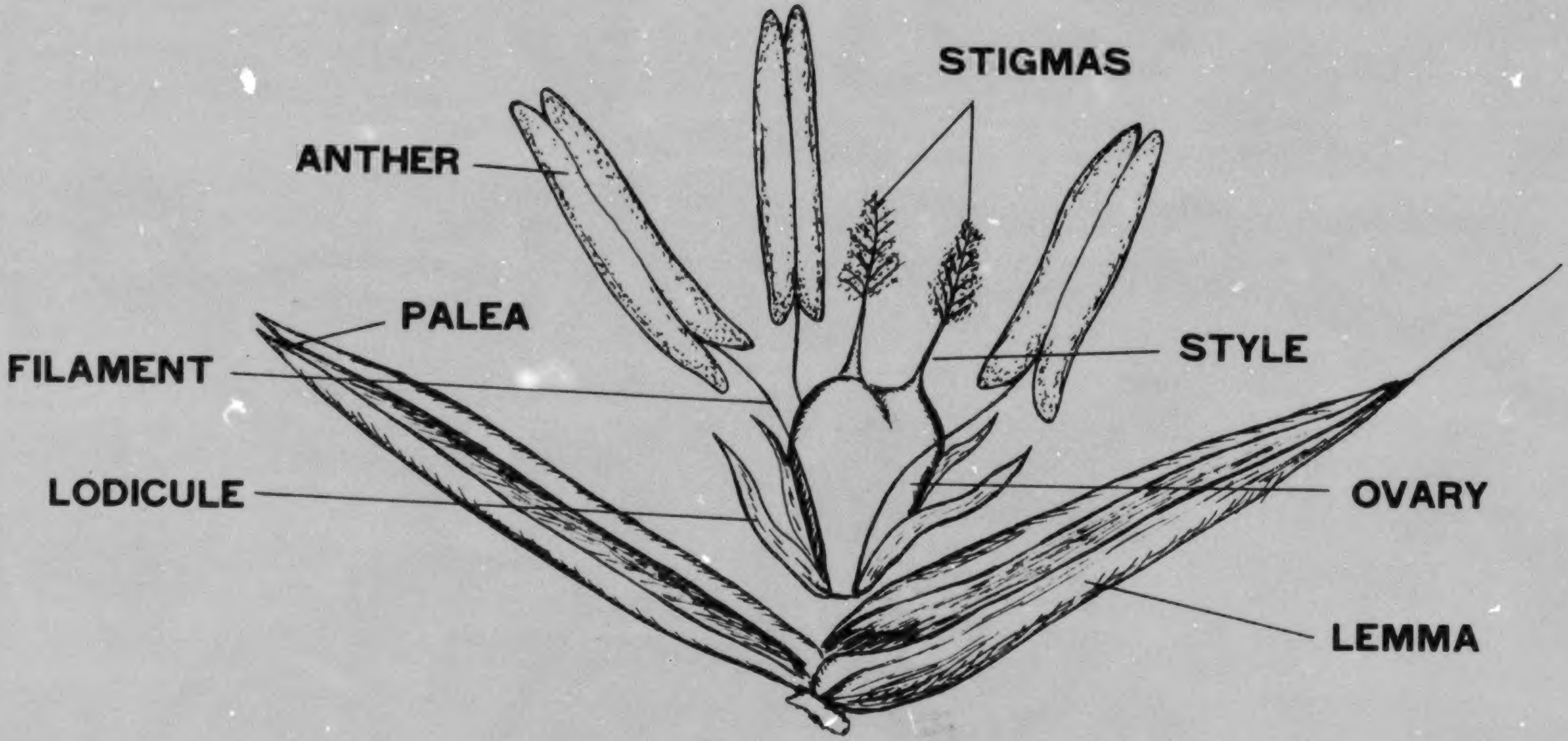
4. Klingman, Glenn C., Crop Production in the South, John Wiley & Sons, Inc., New York, NY, 1967.

5. Martin, John H. and Warren H. Leonard, Principles of Field Crops Production, The Macmillan Company, NY, 1965.

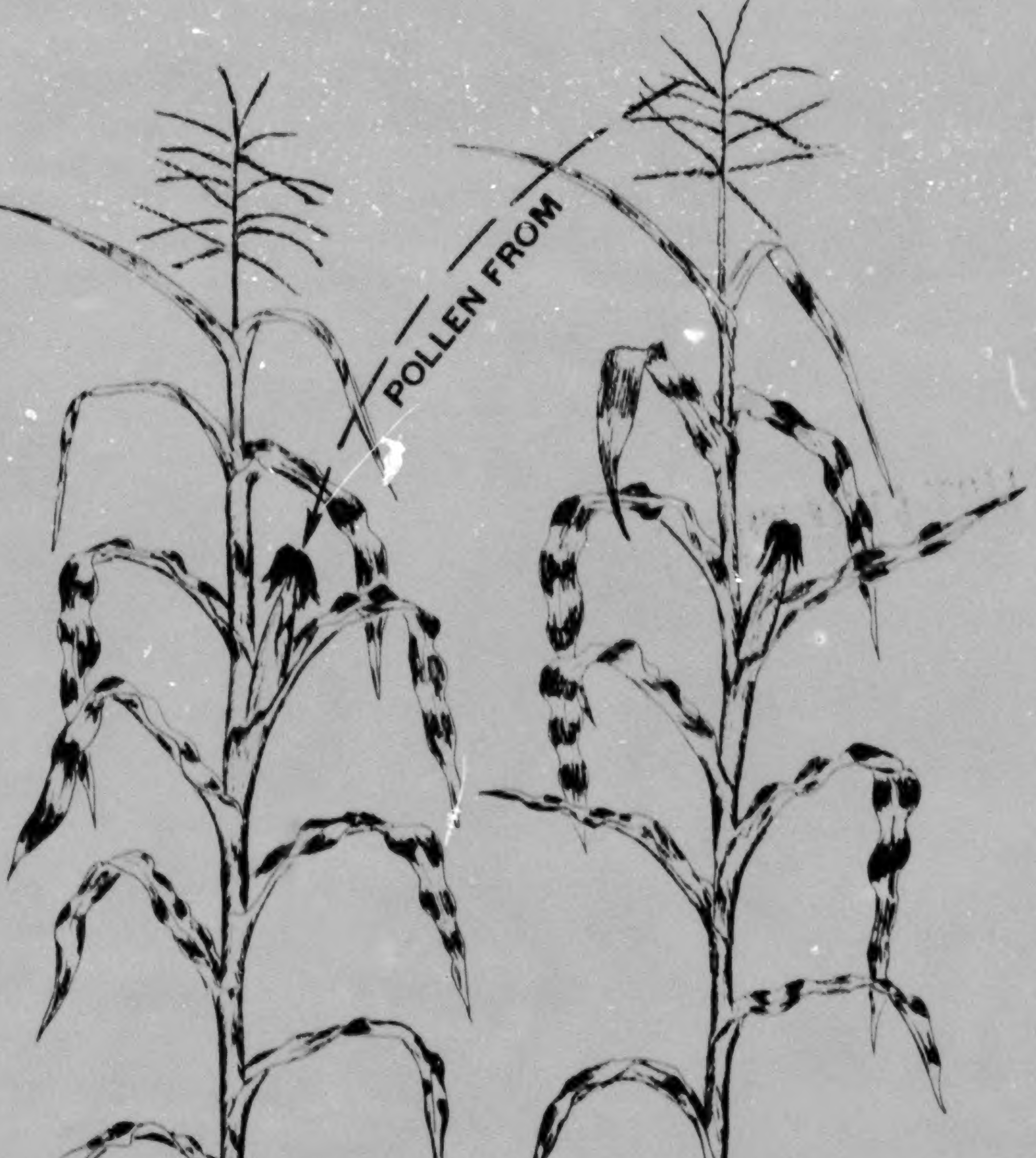
PARTS OF TYPICAL FLOWER SHOWING POLLEN TUBE DEVELOPMENT


STIGMA
SPERMS
STYLE
ANTHER
FILAMENT
PETAL
OVARY
SEPAL
POLLEN GRAINS
TUBE NUCLEUS
POLLEN GRAINS IN ANTHER
POLLEN TUBE
OVULE
EMBRYO SAC
MICROPYLE
RECEPTACLE

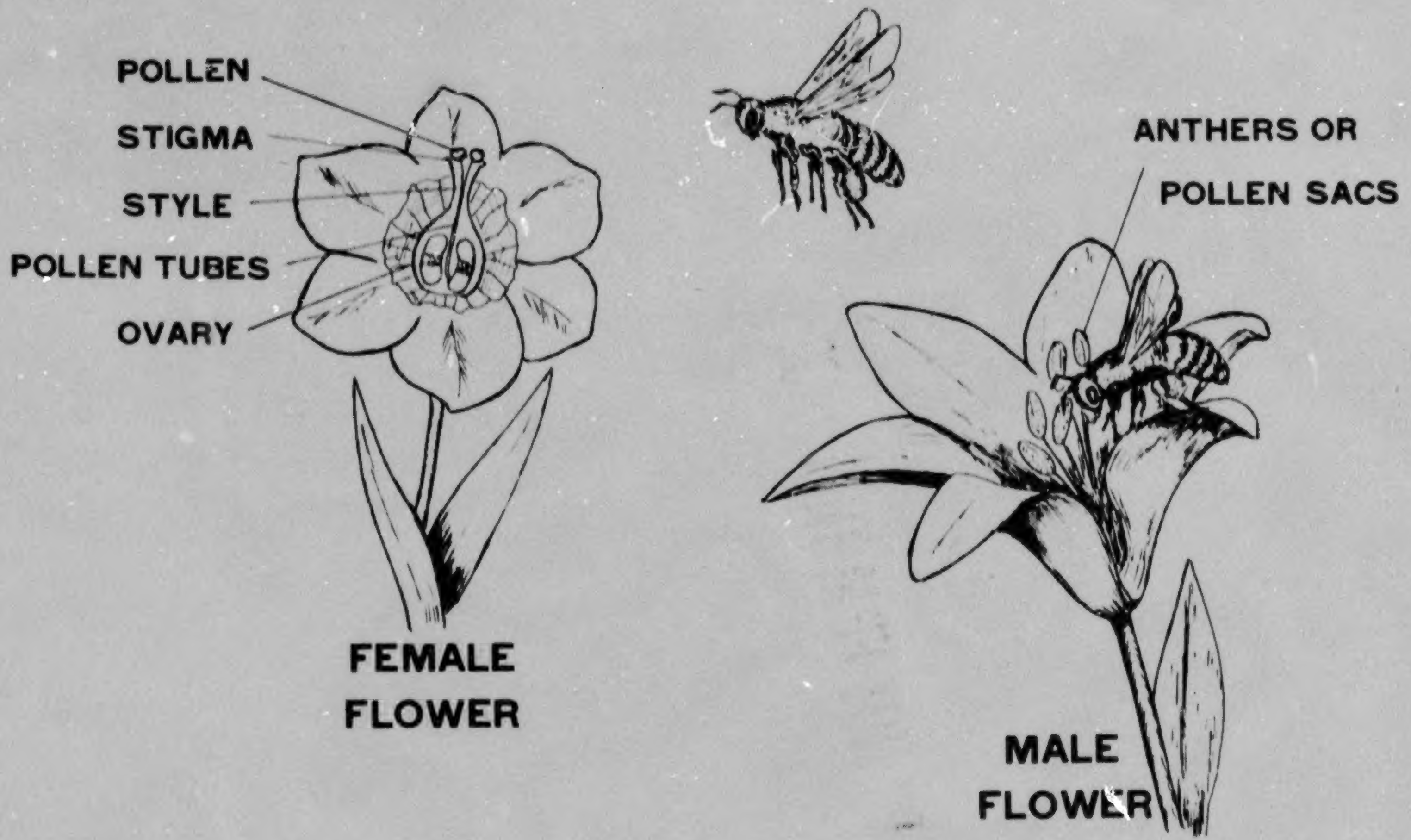
GRASS FLOWER


STIGMAS
ANTHER
PALEA
FILAMENT
STYLE
LODICULE
OVARY
LEMMA

CROSS POLLINATION
MONOECIOUS PLANT


POLLEN FROM

POLLINATION OF IMPERFECT FLOWER
DIOECIOUS PLANT


POLLEN
STIGMA
STYLE
POLLEN TUBES
OVARY
FEMALE FLOWER
ANTHERS OR POLLEN SACS
MALE FLOWER

PLANT SCIENCE

Unit D: Reproduction

Topic 2: Asexual Reproduction

Suggested Procedure and Activities: Transparencies may be used to discuss lesson parts 3, 4, and 5. Plant specimens for asexual reproduction presented to the class during the lesson discussion may be of value.

1. Asexual Reproduction - A Method of Producing Crop Plants

Asexual reproduction is without sexual action; it does not involve the fusion or uniting of the sperm and ovum. It eliminates the dependence upon flower pollination and fertilization that is necessary in sexual reproduction.

Asexual reproduction is called vegetative reproduction or propagation, because a part of the growing plant is used instead of seed for propagation. The vegetative parts of many plants have the capacity to produce new roots and new shoots as found in cuttage and layerage. Plant parts also unite by forming a vascular connection or cambium union as found in budding and grafting.

2. The Importance of Vegetative Reproduction

a. The cutting from a parent plant will have the same genetic make-up as the parent plant. In many seed-bearing plants, seedlings are different from the parent plants in quality when produced directly from the seed. A pecan seedling grown from the seed will produce fruit but it may not possess the desired characteristics for the variety; the fruit may be inferior in quality. This condition usually exists when the parent plant is a hybrid.

b. Sugarcane, seedless grapes, navel oranges, bananas, and certain sterile hybrid plants do not produce viable seed; therefore, it is necessary to propagate such varieties by vegetative propagation. Such plants could be lost entirely if the present parent plant died and there was no vegetative method to propagate them. The dormancy period required by some plants that produce seed can be eliminated if the plant is produced asexually.

c. Selection for desired characteristics is more reliable in asexual than sexual reproduction. Propagation of plants asexually give identical characteristics from parent to off-spring.

Selection of mutations (changes) in vegetative reproduction have improved many varieties of plants. As an example, sweet potato improvement has been made by the proper selection of plant mutations. The sweet potato is a close relative of the morning glory. The non-flowering type of sweet potato has been induced to flower by grafting it with the morning glory. Some mutations in tubers (potatoes) have been developed to increase both the quantity and quality.

Transparency No. 1

3. Definitions of Means of Plant Propagation

a. Below ground propagation

Roots - Subterranean (belowground) parts of the plant without nodes.

Tubers - Short thickened parts (stem) of a plant with buds and eyes that grow belowground.

Rhizomes - Plant stems, horizontal belowground; usually sending up a plant and sending down roots at the node.

Stolons - Plant stems aboveground, usually called runners which take root at their nodes, ends or points, producing new plants.

Stem cuttings - Portion of the plant, usually with nodes or eyes (buds), placed in the soil for the purpose of producing a new plant.

Bulbs - Usually grown belowground. Have scalelike fleshy leaves. Considered a stem.

Transparency No. 2

b. Above ground propagation

Layering - New plants propagated from the stems while still attached to the parent plant. The stems root and send up shoots where they are covered with soil.

Cuttings - Part of the plant: root, stem, leaf, or leaf bud placed in a rooting medium for propagation.

Budding - A single bud (a rudimentary stem or branch) is inserted into an incision beneath the bark of a stock.

Grafting - The joining together of one plant part with another so that the cambium layers (living cells between the outer wood-sap and inner bark) of the scion (the twig inserted into the stock) will be in contact with each other.

4. **Vegetative Propagation of Plants by Layering, Cutting, Budding, and Grafting**

a. Layering may be done by covering a part of the stem with soil or by an air-layering process. The latter process is accomplished by making an incision on the stem and wrapping it with a moisture-holding moss and then polyethylene. After roots develop, the stem is cut and planted. Air-layering is performed on branches in shrubs, trees, and vines.

Blackberry, dewberry, strawberry, rose, apple, and plum may be propagated by layerage.

b. There are four main classes of cuttings: root, stem, leaf, and modified stems (tubers and rhizomes).

Usually, if plants produce root suckers they may be propagated by root cuttings. Fruit, such as pecan, apple, pear, and blackberries, may be propagated by cuttings. Sweet potato and horse-radish are also propagated by this method. The roots of these plants are cut in 2 to 3 inch sections and are placed in a rooting medium.

Leaf cuttings from the orange and lemon will produce plants if a small portion of the petiole is attached. This method is used more in tropical plant propagation and to produce ornamentals in the greenhouse.

One of the most successful methods used for sweet potato production is by stem cutting propagation. The propagation of grapes, citrus plants, roses, and figs is mainly through this method. A portion of the stem is inserted in a rooting medium (soil).

Cuttings of modified stems are a very important method for propagating certain grasses, white potatoes, and cassava. The cuttings should have an eye or thickened area for sending down roots and growing shoots.

c. Budding, a form of graftage, is one of the most popular and successful methods used to propagate many fruit and nut trees and roses. It is one of the most common ways to propagate new trees. Budding provides a way to change varieties on new plants. The two types of buds are normal (buds developed normally on the plant at a leaf base or terminally on the stem) and adventitious (buds develop in positions other than where normal buds are found).

d. Grafting is one of the oldest methods of asexual reproduction. It was practiced before the birth of Christ. Scions may be grafted on like or unlike stocks. An example of the former is the grafting of papershell pecans on a wild pecan seedling. The grafting of a plum to a peach rootstock is an example of the latter method where scion and stock are unlike each other.

Some of the different kinds of grafts are: whip, inlay side, cleft, bark, bridge, and inarch.

5. Plant Parts - The Plant Produced from Those Parts

   a. Roots - Sweet potatoes and cassava.

   b. Tubers - Irish potatoes and artichoke.

   c. Bulbs - Onions and garlic.

   d. Rhizomes - Johnson and Bermuda grasses and asparagus.

   e. Stolons - Bermudagrass and buffalo grass.

   f. Stem Cuttings - Sugarcane, sweet potatoes, alfalfa, clover, lespedeza, and sugar beets.

6. The Production of Forage Crops

Many forage crops are propagated either by stolons (runners) or by rhizomes (underground stems).

Asexual reproduction permits the following practices:

Propagate varieties of forage crops that do not produce an abundance of good seed.

Produce plants that maintain the characteristics of the parent plant.

Produce plants with well developed clones (a group of plants produced from a single plant by asexual reproduction).

The selection and propagation of superior plants from varieties that have been produced by sexual means.

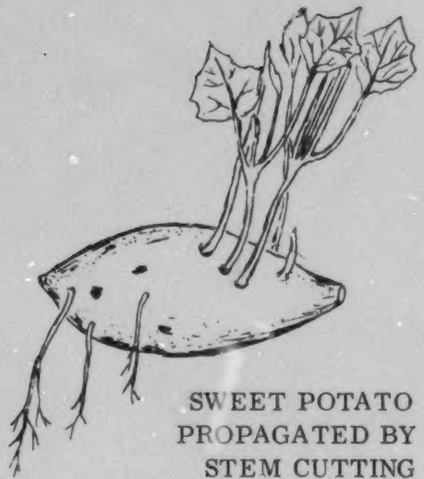
References:

1. Janick, Jules and others, Plant Science: An Introduction to World Crops, W. H. Freeman and Company, San Francisco, CA, 1969.

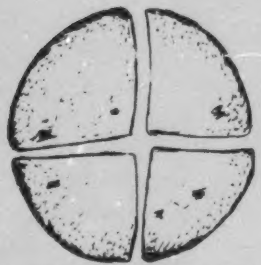
2. Klingman, Glenn C., Crop Production in the South, John Wiley & Sons, Inc., New York, NY, 1967.

3. Martin, John H. and Warren H. Leonard, Principles of Field Crop Production, The Macmillan Company, NY, 1965.

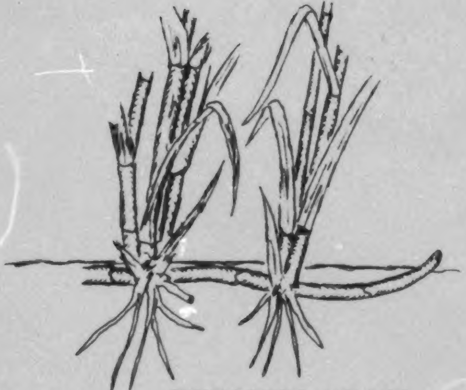
4. Ware, George W. and J. P. McCollum, Raising Vegetables, The Interstate Printers and Publishers, Inc., Danville, IL, 1967.



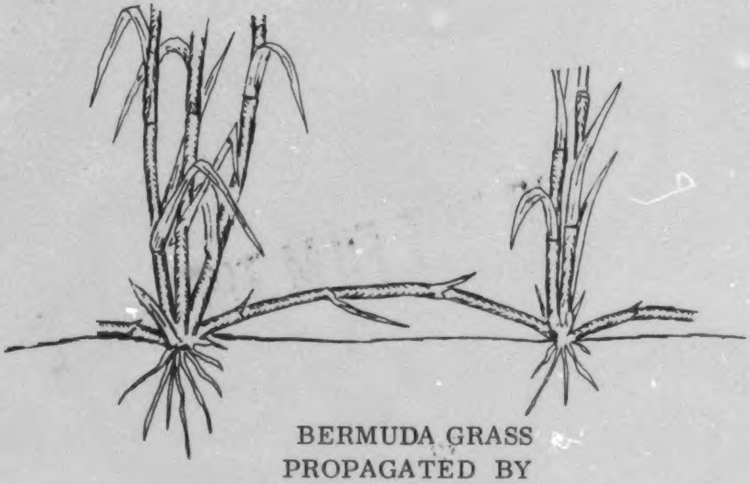
SWEET POTATO
PROPAGATED BY
STEM CUTTING



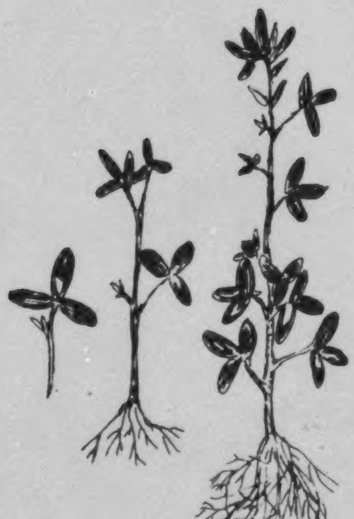
WHITE POTATO
PROPAGATED BY
MODIFIED
STEM CUTTINGS



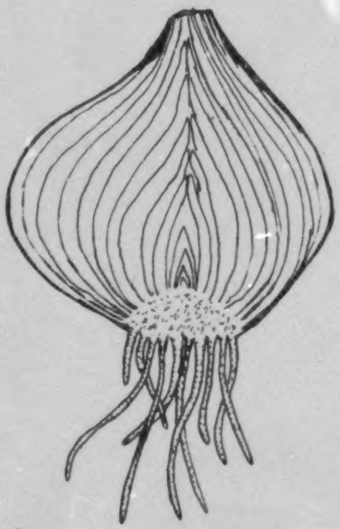
BERMUDA GRASS
PROPAGATED BY
RHIZOMES



BERMUDA GRASS
PROPAGATED BY
STOLONS

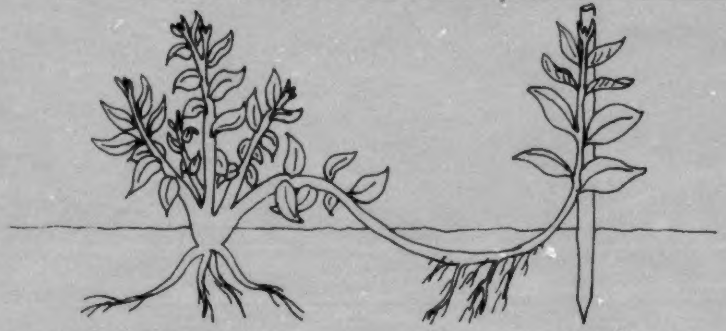


ALFALFA
PROPAGATED
BY
STEM CUTTINGS

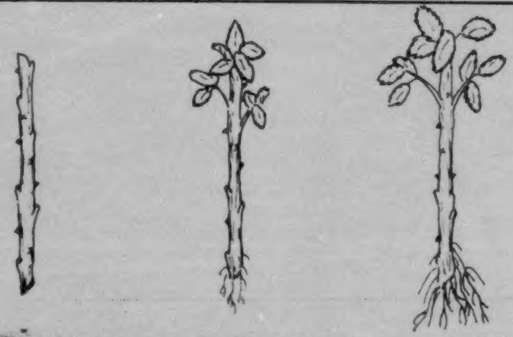


ONION
MAY BE
PROPAGATED
FROM THE
BULB

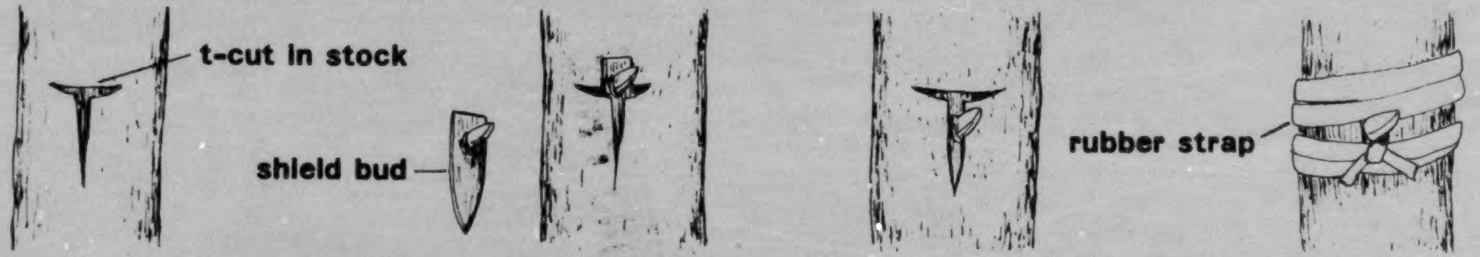
PLANT PROPAGATION



MANY SPECIES OF BERRY PLANTS ARE PROPAGATED BY LAYERAGE

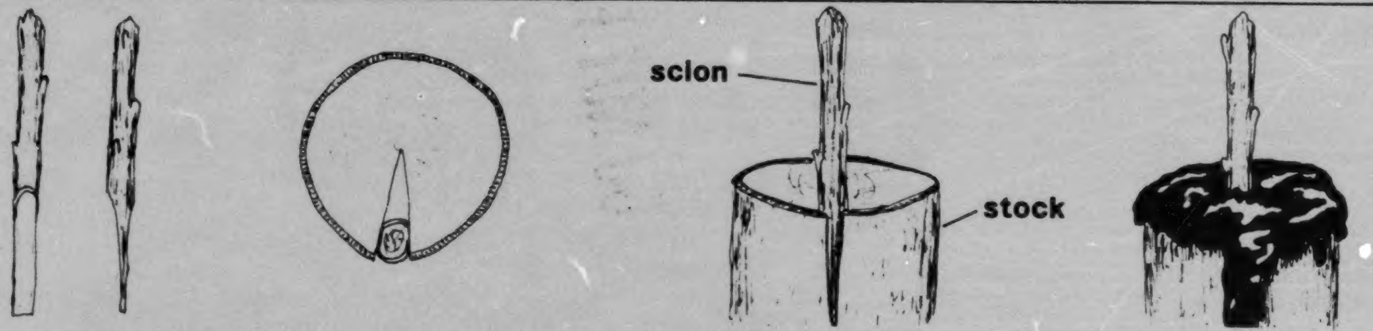


THE PROPAGATION OF ROSES IS MAINLY BY STEM CUTTINGS


t-cut in stock
shield bud
rubber strap

BUDDING IS ONE OF THE MOST IMPORTANT METHODS OF ASEXUAL REPRODUCTION

BUDDING IS IMPORTANT IN FRUIT AND NUT PRODUCTION


scion
stock

GRAFTING IS ALSO USED TO PROPAGATE FRUIT AND NUT TREES

PLANT SCIENCE

Unit E: Seedbed Preparation

Topic 1: Disposing of Previous Residue

Suggested Procedure and Activities: Transparencies may be used to illustrate the ways of disposing of plant residue. Samples of crop residues and soil samples that are high and low in organic matter may add to the discussion,

1. Disposal of Crop Residue - A First Step to Seedbed Preparation

The harvesting of most field crops fails to remove old plant stubble and stalks that hinder cultural operation for future crop production. If weed control practices are not followed, large weed materials may interfere with seedbed preparation and cultivation of the immediate crop.

Crop residue is that part of the crop that remains on the soil after a part of it has been removed by harvest. The remaining part may be in the form of whole root systems, except for plants like potatoes. Plant residues can also be in the form of stubble, straw, leaves, stems, and manure. The decomposition of these plant parts furnishes the organic matter in the upper soil layer. As organic matter decomposes, minerals are made available to plant growth.

Transparency No. 1

2. The Advantages of Disposing of Crop Residues

a. Crop residues and weeds will increase the organic matter in the soil if the residue materials are properly mixed with the soil.

b. The amount of certain plant food elements is increased by the addition of organic matter to the soil.

c. Microorganism growth and action may be improved by mixing crop residues and other plant materials with the soil. The residues serve as a low animal life food.

d. The mixing of fine vegetative trash with the soil tends to pulverize it, making a desirable soil condition.

e. Proper crop residue disposal practices may reduce the crop insect population by destroying the winter hiding places.

f. Plant residue reduces the water runoff rate; therefore, permitting a more desirable rate of percolation or a better soil permeability. A compact soil zone will cause slow percolation and permit more evaporation of soil water. The roots may not penetrate the hardpan.

g. In most cases air circulation and temperature favorable to plant growth are maintained in a soil that contains adequate humus.

3. The Practice of Stubble Mulching

a. Stubble mulching is a common practice in small grain areas, especially where wheat, barley, rye, and oats are grown. Stubble mulching is the tillage beneath the stubble without removing all residues from the surface. Planting is performed through the mulch surface and cultivation beneath the mulch in corn production.

b. Reasons for stubble mulching are:

Water and wind erosion are reduced by leaving most of the crop residue as a cover on the soil.

Stubble mulching enables the soil to take in more moisture and reduce evaporation. It also aids in eliminating a soil top crust due to heavy rains and drying out of top moisture. The permeability (the rate water and air flows through the soil) of the top layer of soil is affected by the compactness and looseness of soil crust particles.

In dry land farming yields are increased where crop residue is used to protect the soil surface. The soil will have a higher temperature in the early spring; therefore, seed germination may be more rapid.

4. Residue, Organic Matter, and Humus

a. The addition of crop residue to the soil is an important approved practice if other soil management practices are included in the soil building program. For example, a well managed soil, high in fertility, will furnish plant nutrients for microorganism growth and plant growth; soils low in nutrients will produce weak and inferior plants due to the microorganisms absorbing nutrients from the poor soil while feeding on the crop residues.

b. The process of producing humus (decomposed plant residue) from plant residue begins when the organic matter is mixed with the soil. In summary the relationship is as follows

Plant residue Organic matter Humus

c. An important factor in plant residue decay is the carbon-nitrogen ratio in the soil and in plant materials. In the United States the average soil has a ratio of 11 pounds of carbon to 1 pound of nitrogen. Cottonstalks, cornstalks, mature grass, and plant straw have a carbon-nitrogen ratio from 60 or 80 to 1. The use of carbon and nitrogen as plant food elements is explained in the steps listed below:

   As soon as plant residue is turned under the soil, bacteria actinomycetes, (rod-shaped bacteria) and fungi begin to feed upon it.

   In most cases about 30 percent of the carbon is used as energy by the soil organisms in digesting the plant residues. The balance is given off as carbon dioxide. Only a small amount of humus is added to the soil in the process. If 2,000 pounds of straw residue is mixed in the soil only about 120 pounds of humus will be produced (that is, if no extra nitrogen is added).

   Plant residues lack nitrogen; therefore, soil organisms use up the nitrogen immediately while they are building their own body tissue.

   After the decay of plant residue is complete, many of the microorganisms die; plants feed on nitrogen released from the dead organisms.

   Organisms compete with the plants for available soil nitrogen which may affect the rate of decay and rate of growth of crop plants.

   The carbon-nitrogen ratio can be narrowed or reduced by applying nitrogen fertilizer to the residues. Other advantages of applying nitrogen fertilizers are:

      More humus is added to the soil.
      The rate of organic matter decay is increased.
      Nitrogen is provided for both the microorganism and the plant.

d. Humus is considered the storehouse for soil base elements (potassium, calcium, and magnesium). It holds base elements in sandy soils and it will hold four times the amount of bases as clay soils.

Transparencies Nos. 2, 3, 4, 5, and 6

5. Methods and Machinery Used in Disposing of Crop Residues

   a. Rotary Chopper and Mower - Cottonstalks must be destroyed in certain areas of Texas where there is an infestation of the pink bollworm. The stalks are shredded with a rotary chopper or mower.

b. Disk Plows - Most of the residue is left on the surface when disk plows are used. The surface residue helps protect the soil against wind erosion in dry regions, and it increases the soil moisture from rain and snow.

c. Subsurface Tiller - The tiller sweeps cut the roots of weeds and crop plant stubble below the surface. The residue and trash remains on the surface to protect the soil. Subsurface tillers are used mainly in dry regions for loosening soil for small grain production.

d. Rotary Tiller - Plant residue is chopped into small pieces and mixed with the soil by rotary plows. It is used in light soils where gardening is practiced. The disadvantage of using a rotary tiller in that it destroys, to a certain extent, the soil aggregate.

e. Chisels - Chisels are used to break compact layers of soil or hard pans. In some areas chiseling is followed by harrowing to finish turning under crop residue and preparing the seedbed.

f. Moldboard Plow - Either single or double moldboard plows have a tendency to cover most of the crop residue leaving the soil surface bare. The lister (plow with two moldboards) is used to make rows or seedbeds. Crops are planted in the trench and on the ridge. The moldboard plow is very popular in the Southern States.

6. Harvesting Crop Residues

a. Some crop residues are sold as raw materials for manufacturing purposes. Each year industry is discovering new uses for certain plant materials that were once discarded as plant residue to be restored to the soil in the form of organic matter.

b. The uses of crop residues are:

Cornstalks - Insulation for buildings, corrugated paper, and livestock bedding.

Straw from Small Grain - Strawboard, corrugated strawboard, glue fillers, bleach papers and boards, and livestock bedding.

Sugarcane - Insulation for buildings, strawboard, corrugated paper, and fiber containers.

Flaxseed straw - Cigarette paper, paper for books, and other high priced papers used in printing.

Corncobs - Cob flour for glues, pipes, material for cleaning and burnishing metal, and wall board.

5. Results of Proper Management Practices - Crop Residues

a. In the Great Plains region where water is an important factor in crop production, wheat yields have been improved by stubble mulching. The wheat residue helped catch and hold the moisture.

Corn yields were improved during dry years in Nebraska, if the land was protected the previous corn growing season by stubble mulching. Stubble mulching proved to be a better land care practice than either burning the residue or residue retained on the surface by subtillage.

b. In Ohio an experiment was conducted on burning cornstalks as compared to plowing under the stalks. Corn and wheat yields were greater on the plots where stalks were plowed under.

c. Experiments were conducted to reveal the difference in disposing of residues in the spring and fall. Little difference was shown in crop yields on spring plowed land as compared to fall plowed land. NOTE: Crop residues should be mixed with the soil at least three weeks before planting, if the residue has been shredded. Where insects are a problem the land should be plowed in the fall or early winter in order to eliminate the crop pests that remain in the plant residues.

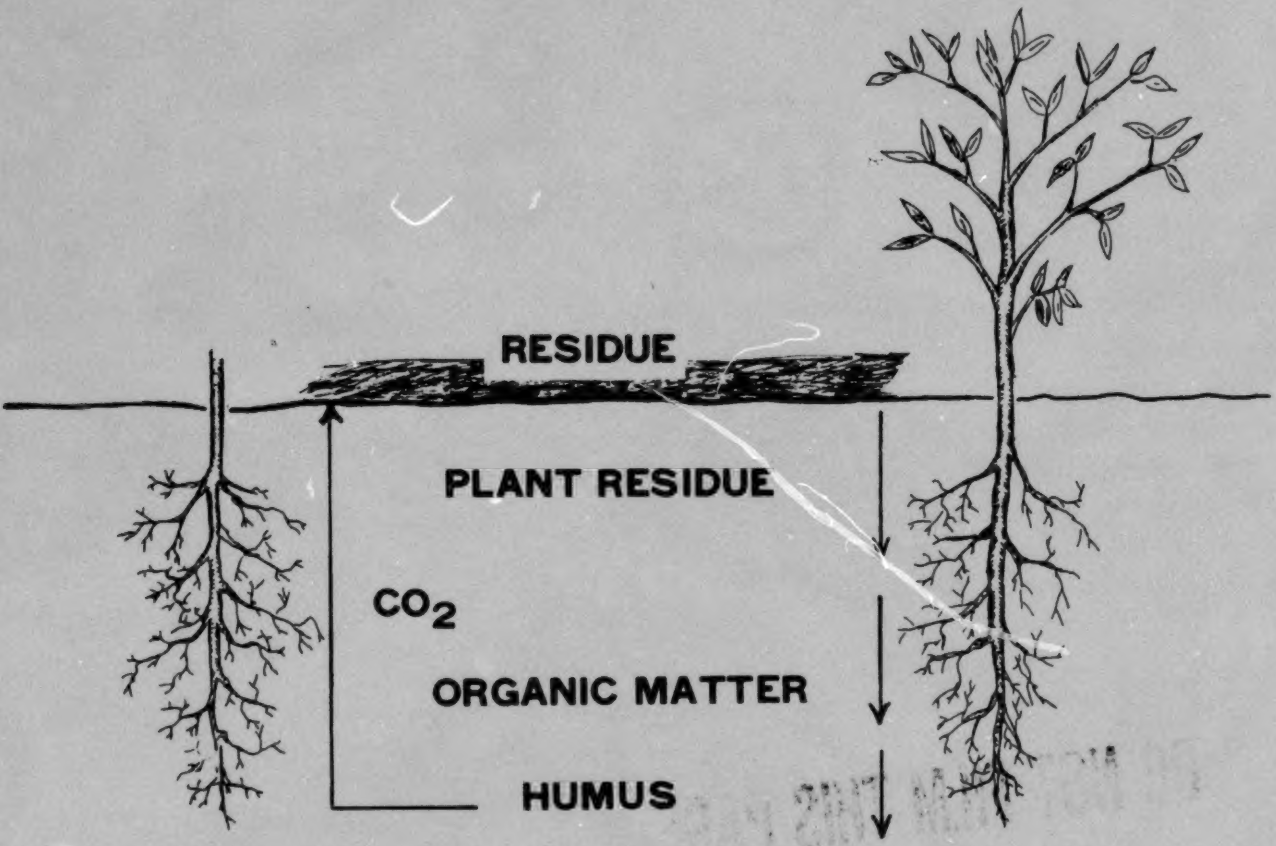
d. Experiments have shown that crop residues help retain large amounts of minerals in the soil and help prevent leaching during excessive rainfall. Research has also shown that a soil high in organic matter maintains its structure.

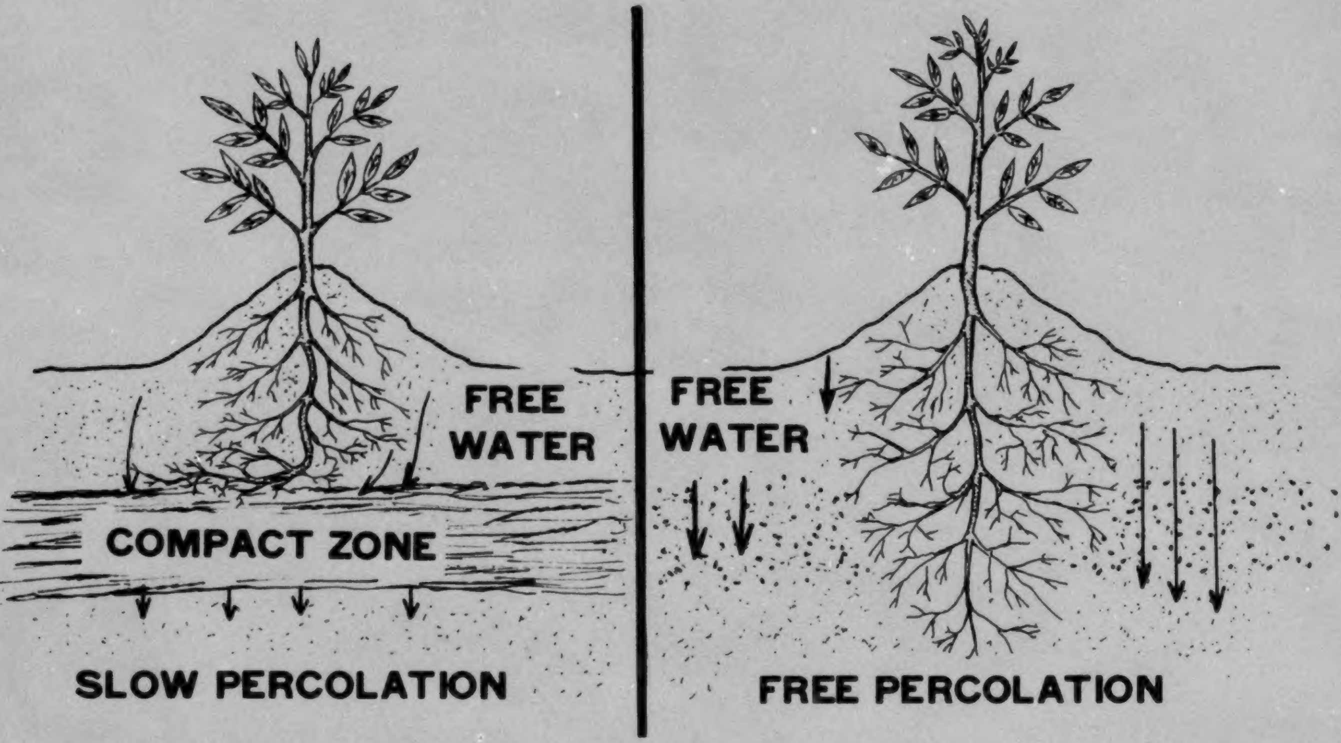
References:

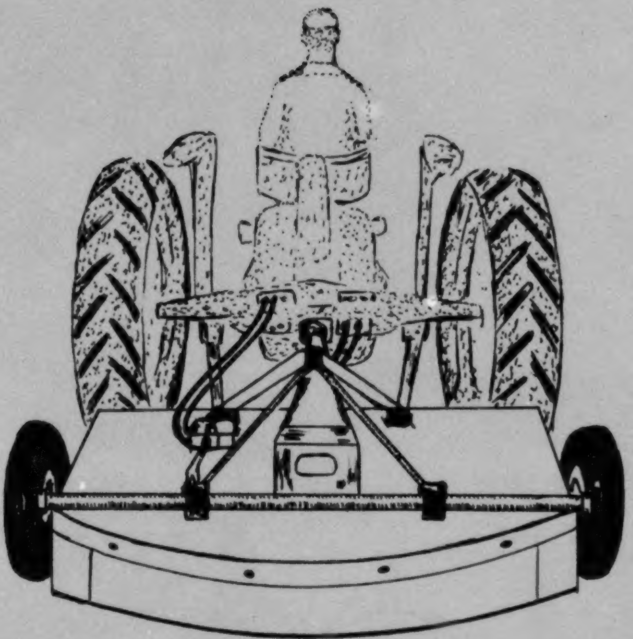
1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1967.

2. Klingman, Glenn C., Crop Production in the South, John Wiley and Sons, Inc., New York, NY, 1967.

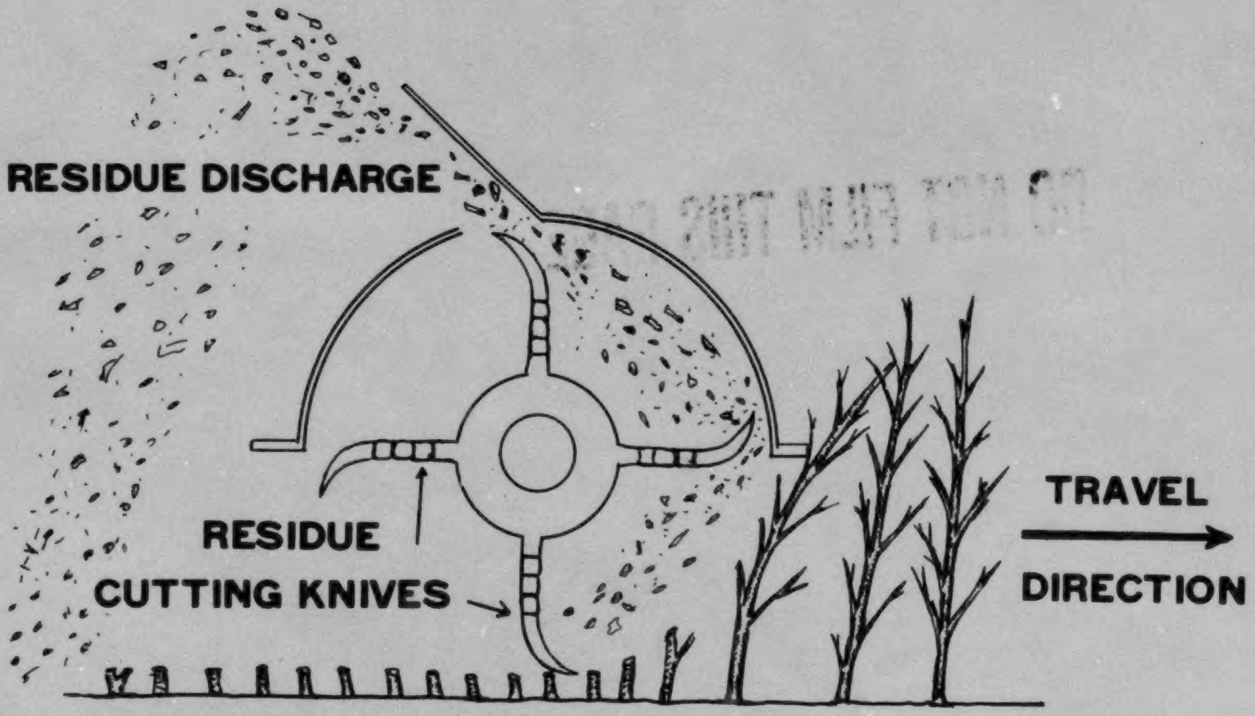
3. Martin, John H. and Warren H. Leonard, Principles of Field Crop Production, The Macmillan Company, Toronto, Canada, 1969.


RESIDUE
PLANT RESIDUE
CO_2
ORGANIC MATTER
HUMUS

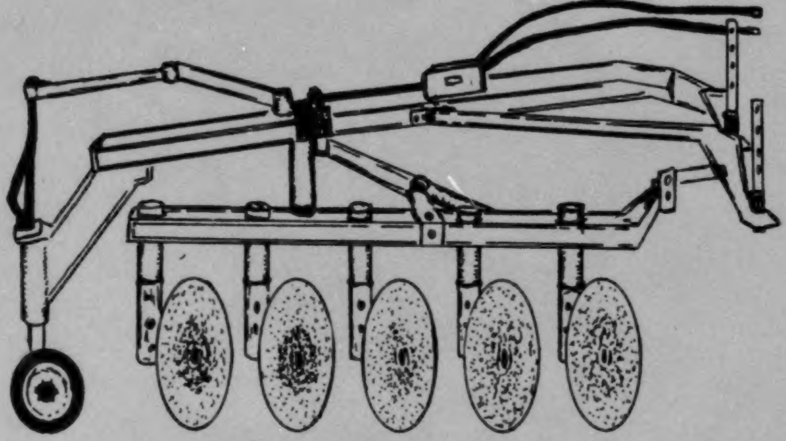

FREE WATER
COMPACT ZONE
SLOW PERCOLATION
FREE WATER
FREE PERCOLATION



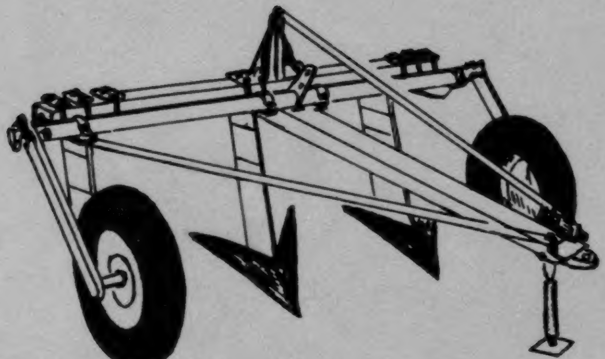
ROTARY CUTTER IS USED TO SHRED STALKS


RESIDUE DISCHARGE
TRAVEL
DIRECTION
RESIDUE
CUTTING KNIVES

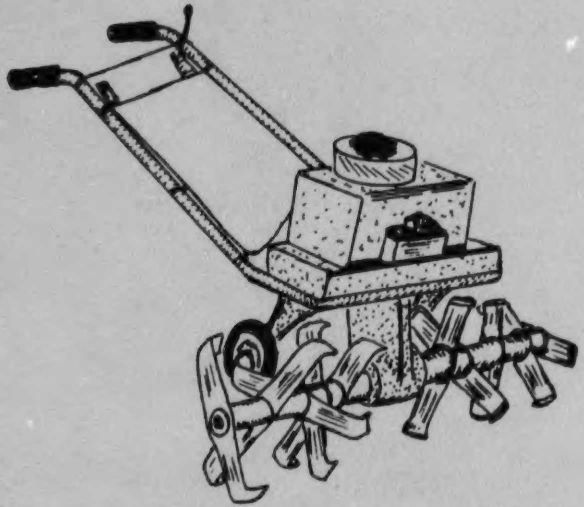
FLAIL ROTARY CHOPPER



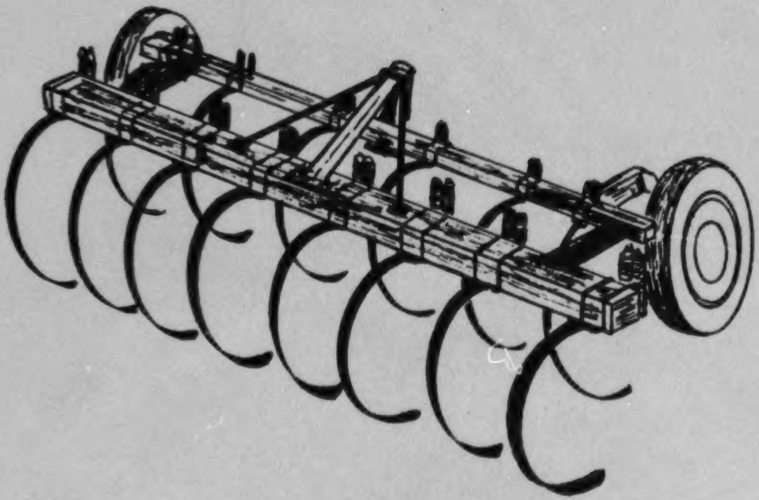
DISK PLOW



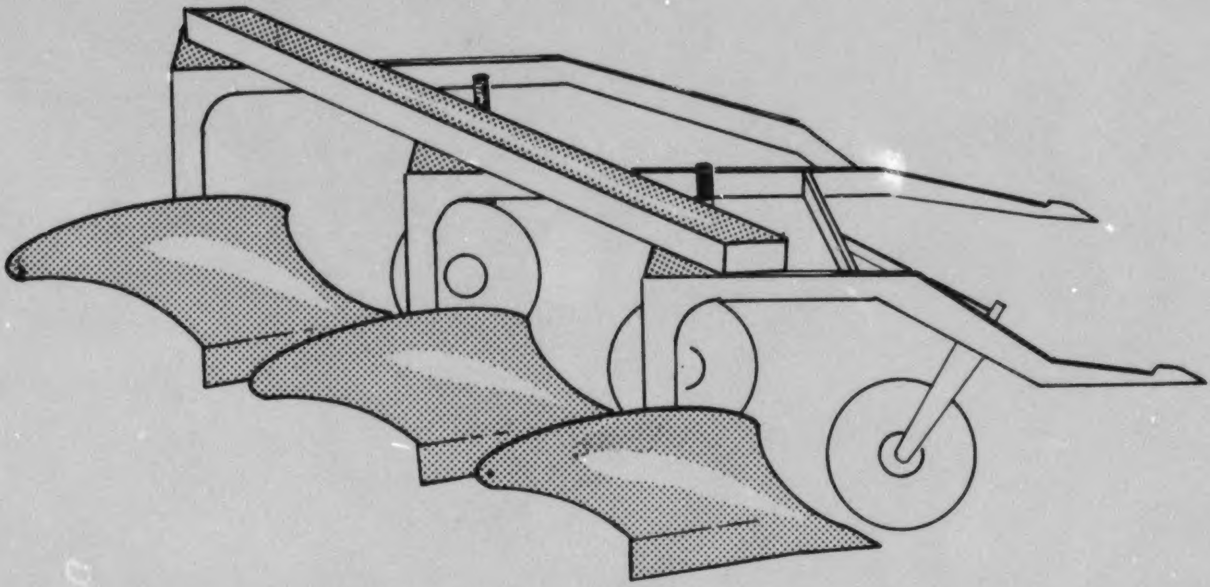
SUBSURFACE TILLER



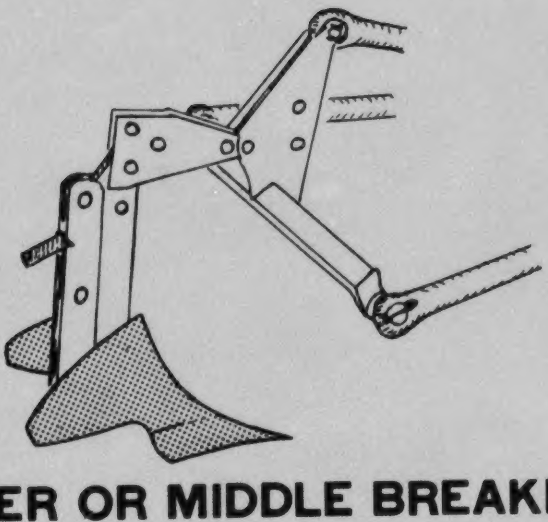
ROTARY TILLER



CHISEL PLOW

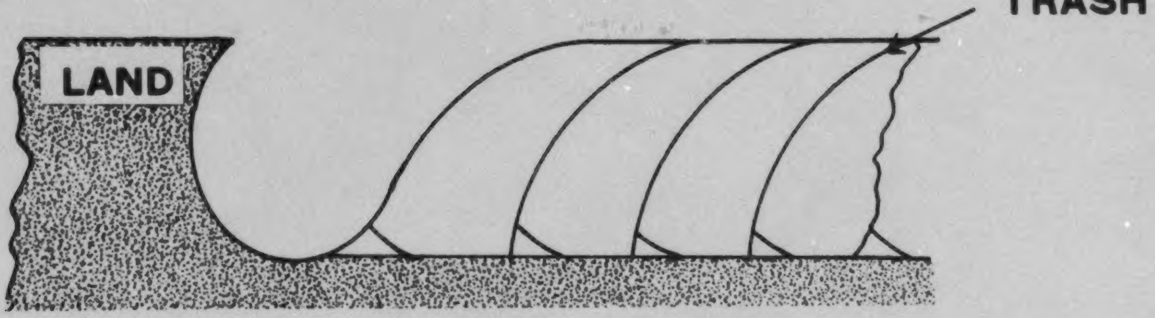


MOLDBOARD PLOW

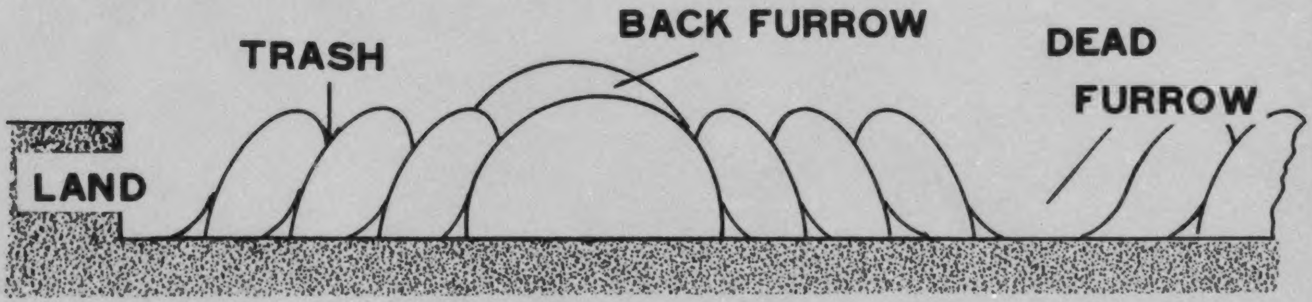


LISTER OR MIDDLE BREAKER

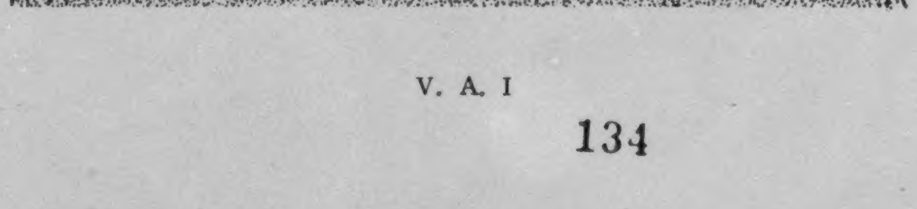
LAND PLOWED WITH A DISK PLOW



LAND PLOWED WITH A MOLDBOARD PLOW


BACK FURROW
TRASH
DEAD
FURROW
LAND

LAND PLOWED WITH A LISTER



PLANT SCIENCE

Unit E: Seedbed Preparation

Topic 2: Land Preparation

Suggested Procedures and Activities: The five transparencies may add to the class discussion, and farm equipment brochures obtained from farm equipment dealers may also help.

1. Tillage - An Early Method of Seedbed Preparation

a. Tillage (seedbed preparation and cultivation) began before mankind kept written records of his farming activities. The first tillage implements were made of wood, stone, or bone. They were used to dig or chop the soil. The crude instruments were also used to make holes in the soil for seeding and to cultivate the plant.

After man domesticated certain animals before the dawn of history, he used them as draft power to drag a plow made of wood through the soil. This system of tillage and cultivation is still a common practice in several under-developed countries throughout the world. Tree trunks and branches are common where animal power is being used.

The steel plow with sharp edged shares was developed in 1833. The plow was accepted even though many thought the iron plow would poison the soil. Implements, such as the disk plow, rotary hoe, harrow, and compactors became the more important types of equipment to stir, pulverize, and compact the soil.

In 1731, Jethro Tull of England stated that plants fed upon the minute particles of the soil, and the finer the soil the more particles were available for the roots to absorb. But, during the nineteenth century, experimental evidence showed that plants needed certain chemical elements found in the soil, as well as water, air, and organic matter in order to grow and produce. Also, it was evident that soil should be in aggregate form instead of every particle being separate; the particles should stick together to make the aggregate or granule.

2. The Three Basic Reasons for Tillage

a. To improve the soil's physical condition for seed germination and plant growth. The soil should have proper pore space for air and water movement to the seed. Soil properly plowed reduces the amount of tillage required for crop growth. About 95 percent of the crop's life cycle is spent in the root bed and only 5 percent in the seed bed.

b. To eliminate weed competition with the cultivated plant, even though it is not as important today as it was a decade ago. Chemicals are replacing tillage as a system of weed control on the seedbed.

c. To improve the soil's chemical and biological condition for seed germination and plant growth.

Transparency No. 1

3. Characteristics of a Good Seedbed

a. The soil should be finely pulverized, yet maintain a porous characteristic. The seed must be in direct contact with the soil particles in order to receive adequate soil moisture. Small seeds require a finer seedbed than large seeds.

b. The soil should be firm enough to prevent rapid drying and furnish a good medium for tiny root hairs. This condition may be found in the lower four inches of the seven-inch seedbed.

c. The soil should be loose and mellow, especially the upper two or three inches. Loose soil will permit better air circulation and seedling growth. It is necessary that plant roots expand easily through the soil.

d. The soil should be free of trash and growing vegetation (weeds). Trash and weeds should be cut into fine pieces and plowed under during the fall, except where wind and water erosion is a problem.

e. The soil should be fertile in the seedbed in order that the young plant will have adequate plant nutrients for fast growth.

f. The soil should be free of insects. Crop rotation, use of insecticides, shredding of stalks and weeds, anf fall plowing will help free the soil of insects.

g. The soil should be free of diseases. Crop rotation, fall plowing, and the use of fungicides help eliminate plant disease problems.

h. The soil should absorb and hold water for seed germination and plant development. Moisture dissolves the nutrients, making them available to the plant roots.

4. The Methods Used in Seedbed Preparation

The methods used to prepare a good seedbed depend upon the type of surface cover and the type of soil. A soil is in good tilth if it contains 65 to 75 percent pore space.

Climatic conditions may also determine the type of equipment to be used for pulverizing the soil, covering trash, and putting the topsoil in contact with the subsoil to facilitate the rise of moisture. Seedbeds should not be prepared if the soil is either too wet or too dry.

Transparencies Nos. 2, 3, 4, and 5

a. The methods of seedbed preparation are:

Use of disk harrow before and after plowing with disk or moldboard plows

If the land is disk harrowed before it is plowed, either with a disk or moldboard plow, good contact is made with the subsoil. Then, if the soil is disk harrowed after it is plowed, an ideal seedbed is provided.

If the soil is plowed and then disked, excessive air spaces appear beneath the plowed soil. This type of tillage reduces the flow of water to the seed. Air and water pore space can be reduced by excessive plowing.

The plowed soil lacks proper contact with the subsoil and is not suitable for a seedbed if only a plow is used. Plowing is only one operation in seedbed preparation. It may be advisable to disk, plow, and disk again.

Disk and moldboard plows are commonly used for seedbed preparation. The disk plow was originally introduced in areas of low rainfall, although it is considered a plow for sticky or waxy land. Due to the rolling and cutting action of the disk plows, there is a smaller problem with shredding and scouring in sticky soils. The moldboard plow is considered more efficient for seedbed-making if the soil is trashy. Organic matter should be sandwiched between furrow slices to take water into the soil. Water movement is stopped if the organic matter is at the bottom of the furrow.

Even though the average seedbed may be from five to eight inches deep, disk and moldboard plows may break the soil much deeper. The depth of plowing is related to the type of soil, climate, residue, and future crops.

The use of a disk harrow for seedbed preparation

The disk harrow may be used above in preparing the seedbed for some crops. It forms a mulch by pulverizing clods and mixing trash with the soil.

Disk harrows stir the soil to a depth of about six inches. They will destroy young weeds and grasses but do not bury insect infested trash or weed seed at a depth to kill insects or prevent weed seeds from sprouting during the growing season.

Listers, known as middle breakers or middle busters, have several uses.

The lister is used to prepare seedbeds for row crops. The soil is thrown both right and left, making a ridge about four inches higher than the surface. If the lister is not used to plow out the first ridge, only half of the soil is stirred. Double listing (passing over the soil the second time) is practiced in some row crop areas.

Lister-planter combinations are used to plant crops in rows. In some areas the lister rows are harrowed down or shaped before the lister-planter passes over the ridge.

In some areas the disk harrow is used before the soil is listed. The depth of plowing, about four inches below and about four inches above the ridge, is not affected by disk harrowing.

Spike tooth and spring tooth harrows are used to smooth seedbeds by breaking up clods and crusted topsoil. Usually a mulch is left on the seedbed after a harrow passes over it.

In some areas chisels and subsoilers are used with disk harrows for seedbed preparation. The chisel or subsoiler passes over the land followed by the disk. A small grain or regular forage crop drill follows the disk over the seedbed.

5. The Proper Time to Plow

a. When to prepare a seedbed may be determined by the following factors:

The type of crop grown the preceding year may cause the seedbed to be partially prepared during the fall.

Weeds may tend to use the nitrates that may be lost due to leaching in heavy rainfall areas; therefore, plowing may be delayed.

Certain areas have heavy rainfall which causes a danger of water erosion. Late fall or winter plowing is considered unadvisable in such areas.

Where wind erosion is a problem the seedbed may be only chiseled in the fall, winter, or early spring.

b. A comparison of fall and spring plowing

Fall plowing advantages

Trash or crop residues have more time to decay and the soil has more time to settle.

The tillage load for preparing the seedbed in the spring is reduced. Crops can be planted earlier.

A rough surface is created to help hold the moisture in low rainfall areas, if the ground is not the type to erode easily.

There is a better chance to form a firm seedbed.

Spring plowing advantages

Practiced on land that erodes easily from wind and water.

Practiced on soil that lacks organic matter. Such soil runs together, thus creating a compact seedbed if such a soil is plowed in the fall.

Eliminates weeds in the early spring. A spring plowing will serve as one cultivation for the ground.

Fall plowing is usually preferred if the climate, soil, and type of crop permits the practice. Experiments with corn, oats, barley, and wheat in different parts of the United States show there is no production advantage between fall and spring plowing or seedbed preparation. Both systems of plowing produce about the same amount of grain per cropping season.

6. The Steps Involved in Seedbed Preparation for Row Crops

As mentioned previously, land preparation varies according to the type of soil, climatic conditions, soil moisture, crop to be produced, the preceding crop on the land, and insect and disease problems. But, generally speaking, the seedbed preparation may include:

a. Plowing the soil when the soil moisture is right with a disk plow, moldboard plow, or disk harrow in the fall or spring may be desirable.

The soil may be disk harrowed or listed (bedded) in the spring.

A spike tooth harrow is then used to drag down the ridges.

It may be necessary to use a land roller or packer or shaper to firm the seedbed before planting the crop. Rollers are usually used on a flat soil surface.

b. Plowing with a lister or middlebreaker in the fall and relisting in the spring is a common practice in some areas.

Ridges or rows may be dragged down with a common drag or harrow.

If the ground is planted in rows, a relisting will take place by the use of a lister-planter.

c. Plowing with a chisel in the fall and early spring is practiced in small grain areas.

The final step in seedbed preparation is made by using a disk harrow.

d. Disk harrowing is a plowing operation to level the soil, kill weed seedlings, make the soil fine, and help to compact it.

Some small grain crop seedbeds are prepared by the disk harrow alone. Spring-plowed ground is usually harrowed soon after it is plowed.

References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NY, 1967.

2. Hughes, H. D. and others, Forages, The Iowa State University Press, Ames, IA, 1967.

3. Hughes, H. D. and others, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1967

4. Martin, John H., and Warren H. Leonard, Principles of Field Crop Production, The Macmillan Company, New York, NY, 1969.

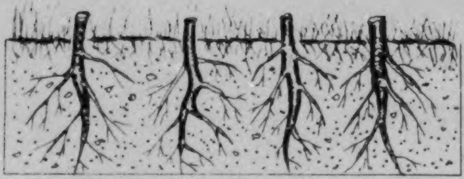
5. Smith, Harris Pearson, Farm Machinery and Equipment, McGraw-Hill Book Company, New York, NY, 1965.

6. "Plows and Plowing", The Ohio Agricultural Education Curriculum Materials Service, Ohio State University, Columbus, OH, 1969.

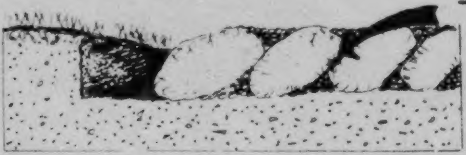
CHARACTERISTICS OF A GOOD SEEDBED

SOIL IS:	
FINE, PULVERIZED	SEED IN DIRECT CONTACT WITH SOIL PARTICLES
FIRM	PREVENTS DRYING . GOOD ROOT HAIR MEDIUM
LOOSE AND MELLOW	PERMITS AIR CIRCULATION AND SEEDLING GROWTH
FREE OF TRASH AND WEEDS	TRASH AND WEEDS SHREDDED AND PLOWED UNDER
FERTILE	ADEQUATE PLANT NUTRIENTS
FREE OF INSECTS	APPROVED PRACTICES OBSERVED
FREE OF PLANT DISEASES	APPROVED PRACTICES OBSERVED
MOIST	ABSORBS AND HOLDS WATER

SEEDBED PREPARATION



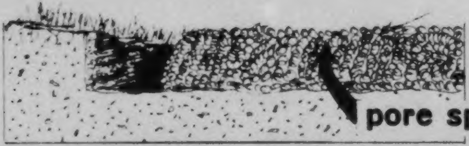
STUBBLE LAND READY FOR PLOWING



organic matter between slices

GOOD SUBSOIL CONTACT

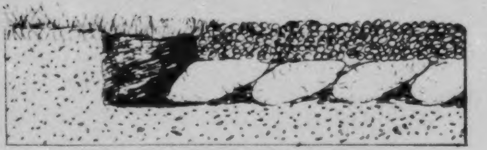
LAND DISKED AND THEN PLOWED



pore spaces between soil particles

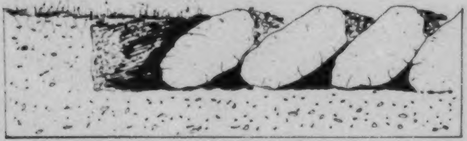
GOOD SEEDBED

LAND DISKED BEFORE AND AFTER PLOWING



LACKS SUBSOIL CONTACT

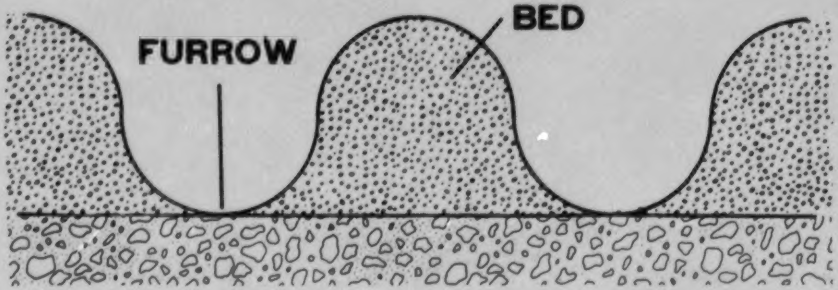
LAND DISKED AFTER PLOWING



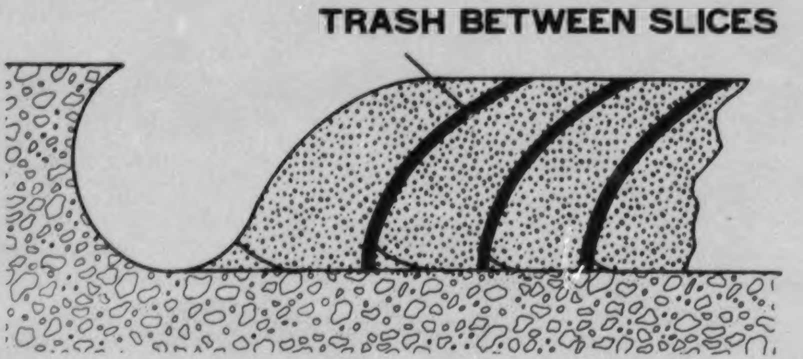
POOR SEEDBED

LAND PLOWED BUT NOT DISKED

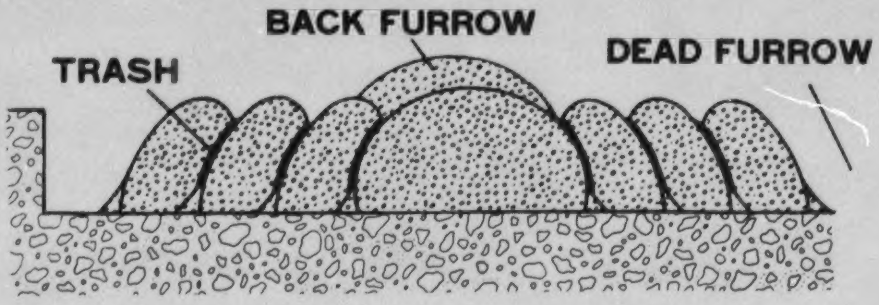
THREE WAYS TO PREPARE LAND FOR SEEDBEDS



LAND PLOWED WITH A LISTER

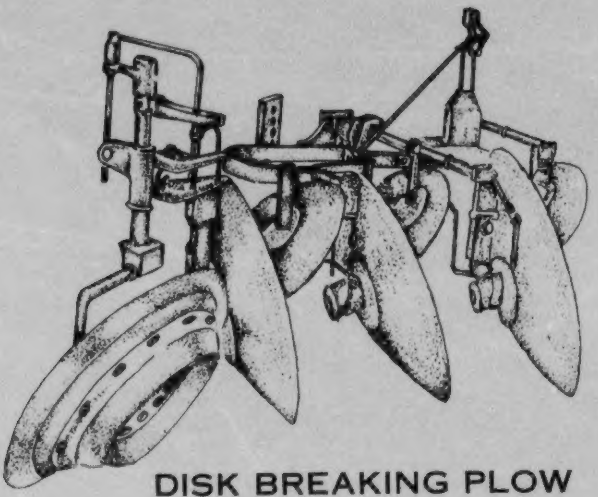

TRASH BETWEEN SLICES

LAND PLOWED WITH A DISK PLOW

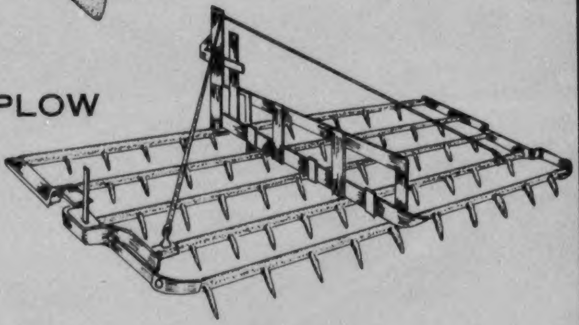

BACK FURROW
TRASH
DEAD FURROW

LAND PLOWED WITH A MOLDBOARD PLOW

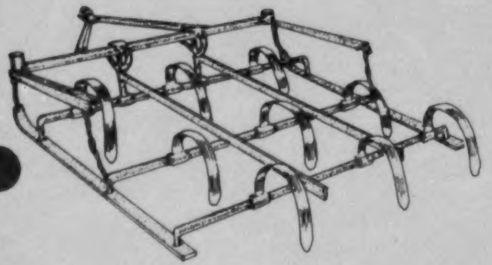
EQUIPMENT USED TO PREPARE SEEDBEDS



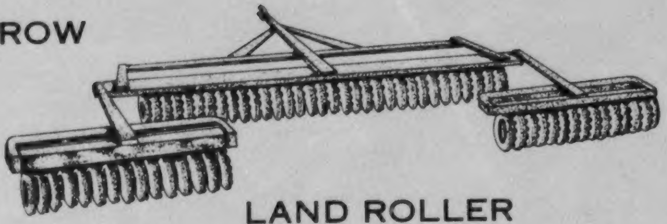
DISK BREAKING PLOW



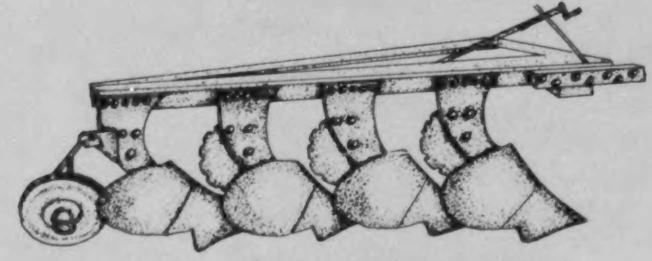
SPIKE TOOTH HARROW



SPRING TOOTH HARROW

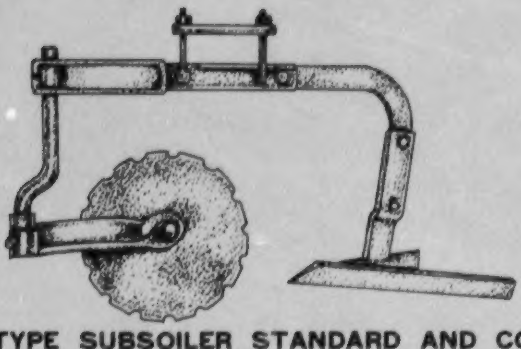


LAND ROLLER

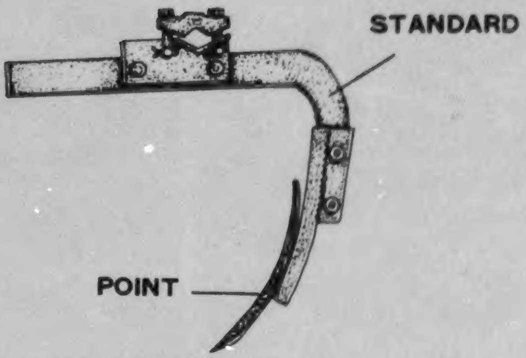


MOLDBOARD PLOW

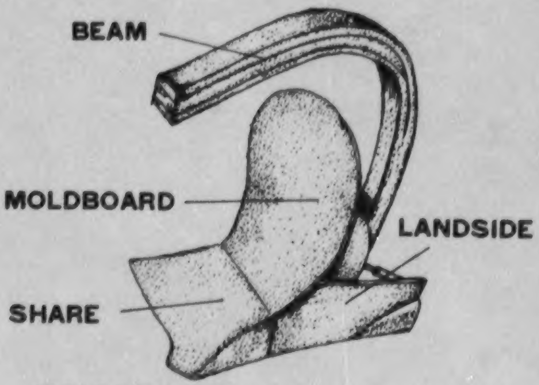
EQUIPMENT PARTS FOR SEEDBED PREPARATION



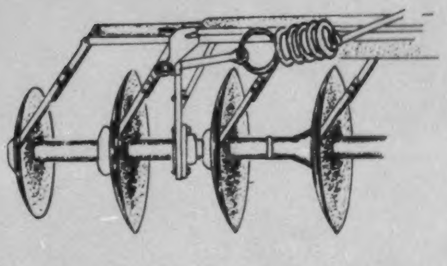
SWEEP TYPE SUBSOILER STANDARD AND COULTER


STANDARD
POINT

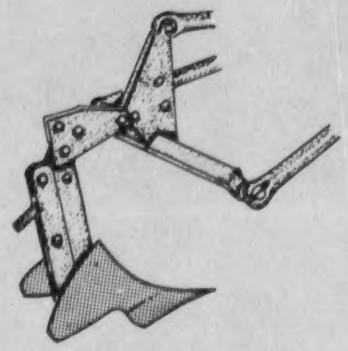
CHISEL SHANK OR
STANDARD AND POINT


BEAM
MOLDBOARD
LANDSIDE
SHARE

MOLDBOARD PLOW BOTTOM



DISK HARROW DISKS



LISTER OR MIDDLEBREAKER BOTTOM

PLANT SCIENCE

Unit E: Seedbed Preparation

Topic 3: Application of Fertilizer

Suggested Procedure and Activities: The transparencies may be used during the class discussion. Other teaching aids, such as fertilizer and soil samples, may be helpful during the discussion.

1. The Purposes of Applying Fertilizer to the Seedbed

a. More than a century ago the statement was made by a German scientist, Justus Von Liebig, that we should return to the soil the plant food which is removed by crops. Naturally, such reasoning was centered around the type of farming that was practiced 100 years ago. Liebig showed that certain plant nutrients such as nitrogen, phosphorous, and potassium were used to increase plant growth. As early as 1849, superphosphate was being produced from bones and sulphuric acid and sold as a commercial fertilizer.

Adding plant nutrients to the soil to increase plant growth is not a recent discovery. The ancient Greeks, Romans, and Chinese used fertility practices to improve plant production. Animal manure, fish, bone, marl (silt, sand, or clay containing calcium carbonate), chalk (a limestone), ashes, and guano (term usually used to identify bat and waterfowl manure) were the first fertilizers used by man. When the early settlers arrived on the North American Continent, they found the Indian using fish to fertilize his corn. Corn yields were increased by placing a fish beneath each hill of corn.

b. The major purpose of fertilizing a soil is to enrich it, or make it more productive. Most soils do not contain adequate quantities of plant food; therefore, it is necessary to add fertilizers to help eliminate plant food deficiencies. Fertilizer is also applied to the soil to make farming a profitable business.

c. Plant food nutrients and their functions are:

Nitrogen - Vegetative growth depends upon nitrogen as a plant food. It must be applied, available in the soil, or furnished by leguminous plants. Nitrogen is readily available to crops, but it is also easily exhausted through soil erosion and leaching. Other effects of nitrogen on plant life are:

Makes the plant grow fast and gives it a dark green color.

Increases the quantity and quality of the plant leaf and adds to fruit and seed yield.

Increases the protein content in plants.

Serves as a food for microorganisms while they decompose organic materials.

Phosphorous - Plants must have phosphorous in order to develop healthy roots and good seed and reach maturity early. Plants that receive adequate phosphorous get off to a good start early. Usually a very small amount is available as a plant nutrient in one growing season. Other effects of phosphorous on plant life are:

It stimulates early root formation and growth.
It brings about early maturity.
It helps bring about blooming and seed formation.
It makes plants (fall-seeded grains) more winter hardy.

Potash - This plant nutrient helps make strong stalks and helps form a good root system. Other effects of potash on plant life are:

It makes plant resistant to diseases and reduces lodging.
It increases fullness of grain or seed.
It aids in the transfer of starches, sugars, and oils.
It gives winter hardiness to the plant.

Calcium as a Secondary Plant Nutrient - Calcium is used in large quantities in some areas due to it being an active ingredient of lime. Soil with a high acidity (pH) content requires the application of lime. Other effects of calcium on plant life are:

It is essential for root growth plant vigor and stem stiffness.
It neutralizes poisons produced in the plant.
It is essential to grain and seed formation.
It adds calcium to food and feed crops.

Magnesium as a Secondary Plant Nutrient - This plant nutrient helps correct the soil acidity and is an essential part of the plant chlorophyll. Other effects of magnesium on plant life are:

It aids in giving a green color to the plant.
It is essential for the formation of sugar in the photosynthesis process.
It serves as a carrier of phosphorous in the plant.

Sulphur as a Secondary Plant Nutrient - Plants may use as much sulphur as they do other secondary nutrients, including phosphorous, a primary nutrient. It is considered important in protein building in the plant. Other effects of sulphur on plant life are:

It is essential in chlorophyll formation, and it helps the plant maintain a dark green color.

It increases root growth and nodule formation on legumes.

It is essential to seed production and the general vigor of plant growth.

Micro Plant Nutrients - The micro plant nutrients are know as the trace-element plant foods. Micro nutrients are not found in all fertilizers, even though they are important for plant growth. The trace-element plant foods are: boron, iron, copper, manganese, zinc, chlorine, and molybdenum. The effects of the trace-elements on plant life are:

Boron improves quality in crops and seeds of leguminous plants.

Iron is important in the production of green matter in plants.

Copper is important in seed setting.

Manganese increases the availability of phosphorous, calcium, and magnesium, and aids in plant food manufacturing.

Zinc is essential to plant growth.

Chlorine is seldom deficient in field crop production, but it is essential to plant growth.

Molybdenum is used by legumes in nitrogen fixation. It is also important to the production of certain vegetables.

Transparency No. 1

2. The Most Common Types of Fertilizer Used in Seedbed Preparation

a. Commercial Fertilizer

Fertilizers that may be used to supply nitrogen to the seedbed include:

Ammonium nitrate, a solid nitrogen fertilizer, that contains 32.5 to 33.5 percent nitrogen and is completely soluble in water

Ammonium sulphate, a solid nitrogen fertilizer, which contains 20.0 to 21.0 percent nitrogen and is soluble in water

Urea, a solid organic nitrogen compound, which contains 45 to 46 percent nitrogen

Sodium nitrate, calcium nitrate, and calcium cyanamide, solid nitrogen fertilizers that contain 16, 17, and 21 percent nitrogen respectively

Anhydrous ammonia, a gaseous nitrogen fertilizer containing 82 percent nitrogen (Refer to Table I)

Phosphorus may be supplied to the seedbed by adding the following phosphates:

Superphosphate, a rock phosphate treated with sulphuric acid, contains about 20 percent phosphorus.

Triple superphosphate, a rock phosphate treated with phosphoric acid, contains about 45 percent phosphorus.

Liquid phosphoric acid, a liquid fertilizer, contains about 52 percent phosphorus. It may be applied with anhydrous ammonia.

Ammonium phosphates. A reaction of anhydrous ammonia and phosphoric or sulphuric acid, forms ammonium phosphates, such as 16-20-0 and 21-53-0.

Fertilizers that supply potassium to the seedbed are potassium chloride and potassium sulphate. Potassium chloride contains about 60 percent available potassium, and potassium sulphate contains about 50 percent potassium.

Mixed fertilizers are used to supply plant nutrients to the seedbed if more than one nutrient is needed. For example, 1:1:1 (8-8-8) may be the proper ratio to use. It contains eight percent nitrogen, eight percent phosphorus, and eight percent potassium.

Calcium as a plant nutrient is supplied by adding limestone, gypsum, burned lime, and oystershell to the seedbed.

Magnesium as a plant food is supplied from dolomitic limestone. Another source of supply is Epsom salts. (Magnesium sulphate)

Sulphur may be supplied in the form of elemental sulphur, ammonium sulphate, superphosphate, or gypsum. (Calcium sulphate)

Trace elements, iron, copper, zinc, manganese, and boron, may be applied to seedbed soils in sulphate form except boron and iron. For example, copper is supplied as copper sulphate. Boron is supplied in the form of borax. Iron is supplied as iron oxide.

b. Some common types of commercial fertilizers to apply to the seedbed are: 12-12-12, 13-13-13, 16-20-0, 16-6-12, 8-16-16, 0-20-20, 5-10-5, 0-10-30, 8-32-16, 6-24-12, and 0-15-45. Ammonium nitrate, ammonium sulphate, anhydrous ammonium, calcium cyanamide, urea, superphosphate, and aqua ammonia are also commonly used fertilizers. A 5-10-5 fertilizer contains 5 parts nitrogen, 10 parts phosphorous, and 5 parts potash.

c. Crop residue and barnyard manure furnish plant nutrients for maintaining soil fertility in the seedbed.

Leguminous crop residue supplies the seedbed with nitrogen and organic matter. Nonleguminous green manure crops also furnish plant nutrients, but they furnish less nitrogen.

Animal manure is considered a good source of a complete fertilizer for the seedbed. A large quantity of manure is required to produce a small amount of the three major elements. Generally, one ton of animal manure contains ten pounds of nitrogen, five pounds of phosphoric acid, and ten pounds of potash. The nutrient content varies according to the type of animal and the type of feed the animal receives. Several types of dried livestock manures are sold as fertilizer.

3. Factors to Consider in Applying Plant Nutrients

a. Different plant-food elements move at different rates and distances in the soil from point of placement. For example, nitrogen may move readily under favorable conditions, whereas phosphates usually move a short distance from where they are applied. Potash is considered less soluble than nitrogen but more soluble than phosphate; therefore, its rate of movement is usually between that of nitrogen and phosphate.

b. Commercial fertilizers should be applied the proper distance from the seed or roots of plants unless it is broadcast or applied in irrigation water. Excessive amounts of nitrogen and/or potash applied near the seed or roots may cause injury if drying conditions increase the concentration of plant-food elements.

c. It is considered desirable to apply fertilizer as near the seed or plant roots as possible without injury to either seed or roots for the following reasons:

Soil fixation of plant-food elements is reduced if the fertilizer is properly applied. Fixation increased by applying fertilizer too far away from the roots are mixing too much soil with it.

If fertilizer is applied in bands near the plant root, it is less available to growing weeds.

Properly placed fertilizer gives a greater return in quantity and quality for a plant production program and results in a larger net return for produce when marketed.

d. Fertilizer should be applied to make the plant nutrients available for plant use when they are needed. Application of fertilizers may be made prior to planting, during planting, or after the crop is growing.

Transparency No. 2

4. Seedbed Application

Fertilizer may be applied in the following ways:

Broadcast on the surface and mixed with the soil by disking.
Broadcast on the surface without disturbing before plants emerge.
Broadcast and plowed into the soil, creating bands as wide as the seedbed.
Drilled into the soil with the seed.
Drilled into the soil above, below, or on each side of the seed.
Applied at the bottom of the furrow created by the planter plow.

References:

1. Delorit, Richard J. and Henry L. Ahlgren, Crop Production, Prentice-Hall, Inc., Engelwood Cliffs, NJ, 1974.

2. Klingman, Glenn C., Crop Production in the South, John Wiley and Sons, Inc., New York, NY, 1967.

3. McVickor, Malcolm H., Using Commercial Fertilizers, The Interstate Printers and Publishers, Inc., Danville, IL, 1970.

4. "The Fertilizer Handbook," The Fertilizer Institute, Washington, D.C., 1972.

PLANT NUTRIENTS IN FERTILIZER MATERIALS

Table I

Materials	Nitrogen N%	Phosphorous P_2O_5%	Potassium K_2O%	Calcium %	Magnesium %	Sulphur %
Ammonium Nitrate	33.5	--	--	--	--	--
Ammonium Sulphate	21	--	--	--	0.3	23.7
Urea	45	--	--	1.5	0.7	.02
Sodium Nitrate	16	--	0.2	0.1	.05	.07
Calcium Nitrate	15	--	--	19.4	1.5	.02
Calcium Cyanamide	21	--	--	38.5	.06	0.3
Anhydrous Ammonia	82	--	--	--	--	--
Superphosphate	--	20	0.2	20.4	0.2	11.9
Liquid Phosphoric Acid	--	58	--	--	--	--
Ammonium Phosphate	11	48	0.2	1.1	0.3	2.2
Potassium Chloride	--	--	62	--	0.1	0.1
Potassium Sulphate	--	--	53	0.5	0.7	17.6

TRACE ELEMENTS (NUTRIENTS)

COPPER
ZINC
MANGANESE
IRON
BORON
CHLORINE
MOLYBDENUM

MIXED FERTILIZER
(SUPPLIES MORE THAN ONE NUTRIENT)

EXAMPLE: COMPLETE FERTILIZER

RATIO OF 1 — 2 — 1 MAY BE 5 — 10 — 5

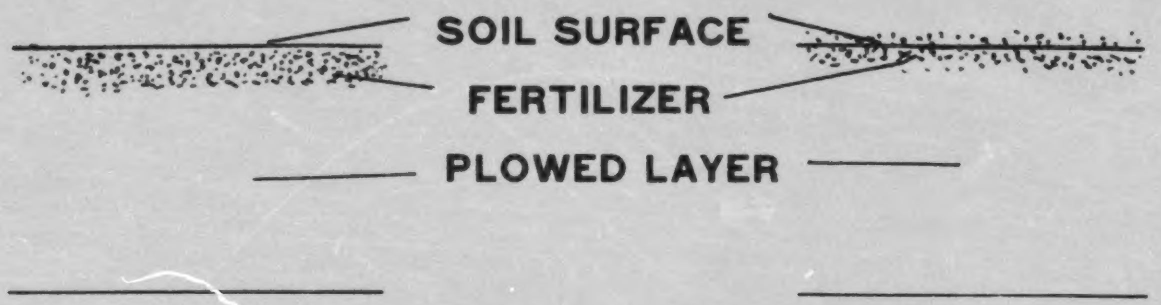
100 lbs. OF 5 — 10 — 5 IS

5% OR 5lbs. NITROGEN

10% OR 10 lbs. PHOSPHORIC ACID

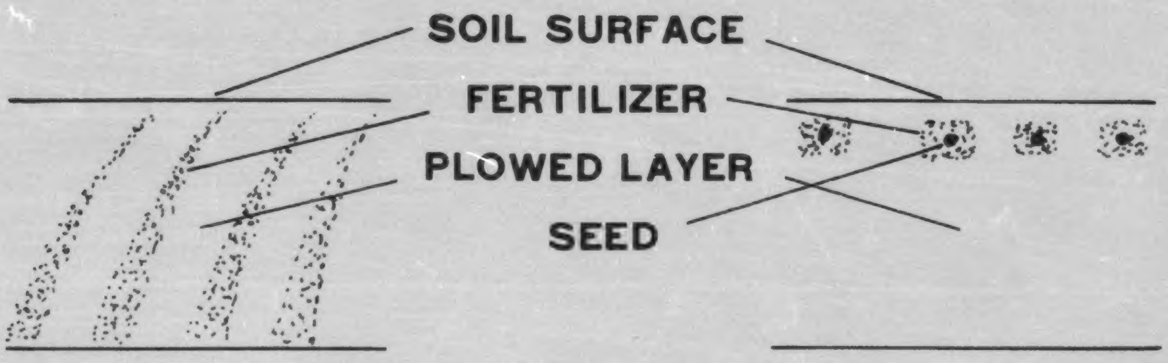
5% OR 5 lbs. POTASH

METHODS OF APPLYING FERTILIZER


SOIL SURFACE
FERTILIZER
PLOWED LAYER

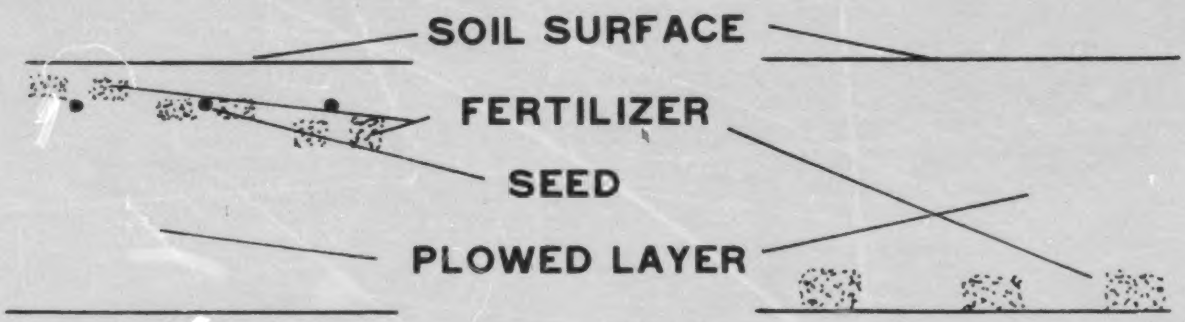
BROADCAST AND DISKED

BROADCAST


SOIL SURFACE
FERTILIZER
PLOWED LAYER
SEED

BROADCAST AND PLOWED INTO THE SOIL

DRILLED IN WITH SEED


SOIL SURFACE
FERTILIZER
SEED
PLOWED LAYER

DRILLED IN ABOVE, EACH SIDE, AND BELOW SEED

APPLIED AT BOTTOM OF PLOW

PLANT SCIENCE

Unit E: Seed Bed Preparation

Topic 4: Irrigation

Suggested Procedure and Activities: Transparencies may be made from the irrigation masters. Samples of soil types containing various amounts of moisture may be helpful.

1. History of Irrigation Practices

a. Before 200 B.C.

Water from the Nile was used to irrigate crops in the desert lands of Egypt, about 330 B.C. The world's oldest dam was built over 5,000 years ago on the Nile in Egypt. It furnished water for drinking and irrigation.

The Chinese began irrigating their farm lands at least 4,500 years ago. It is believed that the Chinese developed the water ladder for lifting water from streams and reservoirs.

Early writings point out that the country south of India was very prosperous because two crops per year were harvested from the fertile land. Irrigation practices permitted Ceylon to produce an abundance of food in the semiannual harvest.

b. After 200 B.C.

China built the Tu-Kiang Dam in about 200 B.C. It is still used to furnish water for about 500,000 acres of rice.

The Sui Empire (589-618 A.D.) constructed the 700 mile long Grand Canal in China to furnish irrigation water for rice and consumption.

The Indians of North America constructed canals in the arid regions of the west to irrigate their corn. These irrigation practices existed as early as 700 A.D.

The Mormons pioneered irrigation for crop production in the United States, about the middle of the nineteenth century. The Spanish priests also developed irrigation in the Western states, but the irrigation projects were usually small (gardens, orchards, or vineyards).

c. Early methods used to lift water were the bucket and counterweight pole, chain of pots on an endless rope, and the water screw.

Transparency No. 1

In 1890, over three and one-half million acres of land were under irrigation in the western states. Texas alone has over six and one-half million acres of raw crop and pasture land under irrigation. The 1973 agricultural census estimated that there are 35,500,000 acres irrigated in the United States. By 1985 over 38,000,000 acres will be irrigated.

2. The Meaning of Irrigation

a. There are several definitions that may be applied to the term irrigation.

Irrigation is a way of supplying water to the soil artificially. It is a means of maintaining a continuous supply of moisture to plant seeding and plant root zones in the soil.

The meaning of irrigation is expressed in the following objectives:

To add water to the soil in order to insure prompt seed germination (Preplant irrigation).

To provide the proper amount of water for plant growth (Post-plant irrigation).

To reduce the chance of producing a short crop due to drought (Preplant and Post-plant irrigation).

To make a more favorable plant environment for plant growth, either by cooling the soil or protecting the plant from a freeze. Also, plow pans are softened by adequate soil moisture.

To dilute or wash out salts that become concentrated in the soil.

To improve the quantity and quality of crops produced.

To supply water to crops where the rainfall is adequate but not distributed properly during the growing season.

Transparency No. 2

3. The Principal Methods of Irrigation and Features to Consider

a. Sprinklers - Water is sprayed through the air, similar to rainfall, by sprinklers that are operated at pressure up to 120 pounds. Water movement is downward in the soil. Perforated pipe or tubing is also used in the sprinkler method of irrigation.

Crop adaptability - All major farm crops except rice.

Soil adaptability - All irrigatable soils suitable for growing field crops, perennial grasses, and legumes. This method is especially adapted to sandy soils that take in water rapidly.

Other features to consider - Sprinklers offer a good method to irrigate too steep, too shallow, or too rolling soils; water can be controlled to provide uniform wetting; the initial and operating cost are expensive; evaporation rate may be high due to weather conditions; and labor cost may be high due to pipe movement.

b. Surface Irrigation - Water flows by gravity in furrows or over the ground surface where it is controlled by borders, dams, and gates. Water movement is downward and outward in rows and downward in border irrigation.

Crop adaptability - Furrows are used for row crops; contour borders are used for rice, pasture, small grain, or orchards; graded borders are used for pasture, small grain, and hay crop irrigation.

Soil adaptability - Medium to fine textured soils with not more than two feet of slope per 100 feet.

Other features to consider - Initial cost is usually less than sprinkler (overhead) irrigation; labor costs are low; insecticides can be used on the foliage; may require land leveling; and graded borders may interfere with farming.

c. Subsurface Irrigation - Water is supplied below the root zone but near the surface. Subsurface water can be supplied to the plant in open ditches or by using pipe that contains tiny holes. Capillary action carries water to the plant roots.

Crop adaptability - Furrows and pipe may be used for row crops to furnish plant moisture below the root system. Pipe may be used for non-row crops.

Soil adaptability - Medium to fine textured soils with moderate to no slope and clay or rock to slow the downward movement of water.

Other features to consider - Labor costs are low, but the initial cost is high. It is a good method to use to eliminate evaporation and aid in controlling plant diseases.

4. Sources of Water Supply

a. Perennial streams were one of the first sources of water supply for irrigation. Since 1930, dams have been constructed on the streams, eliminating their dependence on rainfall for an adequate irrigation water supply. Many perennial streams are fed by springs and high snow covered areas in mountain regions, but most streams of this type have a continuous supply of water furnished by rainfall and springs.

b. Reservoirs, ponds, and lakes impound water from drainage areas to irrigate a limited acreage. Reservoir, pond, and lake water is limited due to the following factors:

Water requirements or crops to be irrigated.
Application efficiency of the irrigation system.
Losses due to evaporation and seepage.
The amount of rainfall and water held in storage.

c. Canals and pipelines are major sources of water where communities have organized irrigation districts. Water usually comes from reservoirs and streams and is controlled by a water control agency.

d. Wells are considered one of the most dependable sources of irrigation water. Only deep wells that are drilled or put down by tamping are used to supply irrigation water. Wells are a major source of water supply in certain areas. The High Plains area of Texas received its entire supply of irrigation water from deep wells.

5. How Water Flow is Measured

One acre foot of water means the amount of water required to cover one acre one foot deep. This amount of water is equal to 43,560 cubic feet. Water may be measured in gallons per minute, acre inches per hour, or cubic feet per second.

Several measurement formulas have been developed to determine the amount of water that flows through various sizes of weirs and orifices. In most cases tables and charts containing information on the cubic feet per second water discharge are used to determine the amount of water that flows through orifices and weirs.

6. Soil Properties Important to the Irrigation Program

a. The three major soil properties are: soil texture (size of individual soil particles), soil structure (way particles are grouped together), and soil depth and layering.

The three properties help define the following characteristics of the soil:

Available Moisture - The soil's capacity to store water for plant use.
Permeability - The rate of movement of water through the soil.
Intake Rate - The rate the water enters the soil.

Transparency No. 3

b. Soil properties control root penetration of plants. Usually soil characteristics vary with the lay of the land. The depth and layering of soils will affect root growth and will determine the irrigation practices to use for maximum plant growth without wasting water.

The depth that a root penetrates and its development depend mainly upon soil layering, if adequate moisture is available. Various depths and layering of soils and their effect on root penetration are shown as follows:

(1) Moderately deep over fractured rock
(2) Shallow over sandstone and rock
(3) Loam surface soil over clay, underlain by dense clay
(4) Deep, uniform clay
(5) Deep, uniform sand
(6) Moderately deep over sand and gravel
(7) Very shallow over sand and gravel
(8) Deep, uniform loam

7. When to Irrigate - Critical Periods

a. The periods during which adequate soil moisture is very important are:

All crops	Prior to planting
Potatoes	Blossom to harvest
Melons	Blossom to harvest
Cotton	First bloom through boll-maturing state
Corn	Tasseling through silking
Small Grain	Boot to heading
Pasture	After grazing
Alfalfa	Start of flowering and after cutting
Orchard	Fruit development

b. Determining when to irrigate by crop appearance

Temporary wilting during the hottest part of the day indicates the need for water among root crops.

Alfalfa changes to a dark green color when there is a lack of moisture.

Grain crops wilt during the hottest part of the day if there is a need for water.

The need for water in fruit crops is detected by a wilted appearance of the leaves. Fruit growth may be retarded if this leaf observation method is used for determining moisture needs. Continuous soil moisture tests will insure good production, that is if water use is based upon tests.

c. Determining when to irrigate by estimating soil moisture

Soil moisture content can be either measured by tensiometers, electrical conductance meters, moisture counting (calculating by daily inventory the water remaining in the soil), or the "feel" test.

When using the feel and appearance test, a soil sample is taken by using a shovel, soil auger, or tube. The feel and appearance of a handful of soil that has been squeezed very firmly may be compared with the soil moisture and texture guide (Table I).

If clay loam is estimated to average 50 percent available moisture in a root zone three feet deep, and the soil is estimated to hold 2.0 inches of moisture per foot or a total of 6.0 inches in the root zone at field capacity, then 3.0 inches of water should be added due to 50 percent of the moisture being available.

Depth of water penetration into the soil may be made a day or two after irrigation; water should have penetrated three feet. If the penetration depth is more or less than three feet, the irrigation schedule should be adjusted to give the proper depth of moisture penetration.

8. Irrigation to Improve Crop Stands and Improve Quality

a. High production depends upon a good stand or an adequate plant population per line or foot of row. After the seedbed is prepared for planting the soil moisture must be sufficient to germinate the seed.

Transparency No. 4

b. High production depends upon adequate moisture in the seedbed, before and after seed germination takes place.

Young seedlings require a large amount of top soil moisture for the initial stages of root development, but as the different crop plants mature, the soil must be wetted to the depth that the root will likely penetrate. Listed below are penetration depths of several mature plants:

Irrigated Grass Pastures	1.5 feet to 3 feet
Potatoes	2.0 feet to 4 feet
Beans	2.5 feet to 4 feet
Small Grains	3.0 feet to 5 feet
Corn	4.0 feet to 5 feet
Sugar Beets	3.5 feet to 5 feet
Alfalfa	4.0 feet to 8 feet

Transparency No. 5

c. It is important that the soil contains adequate moisture throughout the root zone even though the plant may use as much as 40 percent of the available moisture in the top one-fourth of the root zone depth. For example, if a potato root penetrates the soil 4.0 feet, 40 percent of the moisture used by the plant will be located in the first foot of soil.

d. To receive maximum production from the potato plant, the last one-fourth or 25 percent of the root zone depth must be moist. Plants use about 10 percent of the moisture in the fourth root zone depth.

References:

1. Delorit, Richard J. and others, Crop Production, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1974.

2. Hughes, Harold D. and Edwin R. Henson, Crop Production Principles and Practices, The Macmillan Company, New York, NY, 1967.

3. Israelsen, Orson W. and Vaughn E. Hansen, Irrigation Principles and Practices, John Wiley & Sons, Inc., New York, NY, 1967.

4. Klingman, Glenn C., Crop Production in the South, John Wiley & Sons, Inc., New York, NY, 1967.

5. "Planning for an Irrigation System," American Association for Vocational Instructional Materials, Athens, GA, 1971.

6. "Irrigation," Soil Conservation Service, U. S. Department of Agriculture, Washington, D.C.

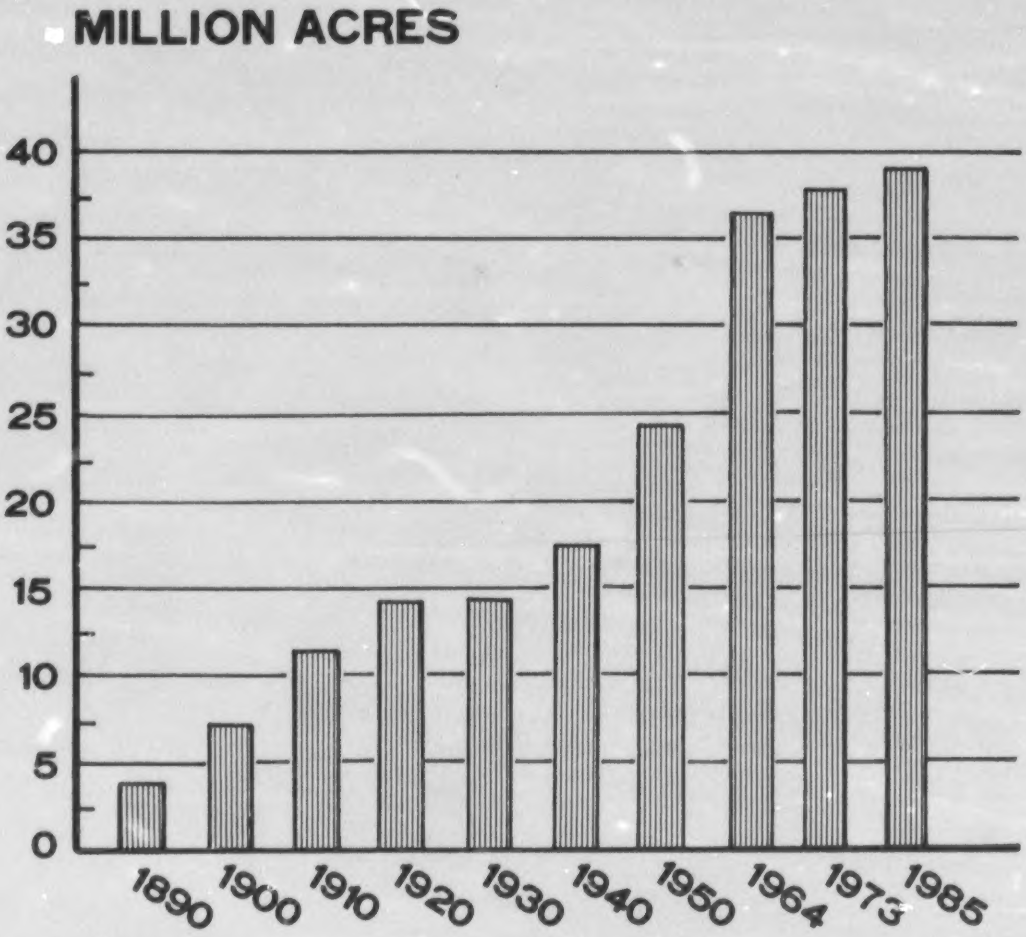
GUIDE FOR JUDGING HOW MUCH MOISTURE IS AVAILABLE FOR CROPS

Table I

Available Soil Moisture Remaining	Feel or Appearance of Soil			
	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine & Very Fine Texture
0 to 25 percent	Dry, loose, single-grained, flows through fingers.	Dry, loose, flows through fingers.	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition.	Hard, baked, cracked, sometimes has loose crumbs on surface.
25 to 50 percent	Appears to be dry, will not form a ball with pressure. *	Appears to be dry, will not form a ball.*	Somewhat crumbly but holds together from pressure.	Somewhat pliable, will ball under pressure. *
50 to 75 percent	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure but seldom holds together.	Forms a ball, somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and forefinger.
75 percent to field capacity (100 percent)	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.	Forms a ball is very pliable, slicks readily if high in clay.	Easily ribbons out between fingers, has slick feeling.
At field capacity (100 percent)	Upon squeezing, no free water appears on the soil, but wet outline of ball is left on the hand.	Upon squeezing, no free water appears on the soil, but wet outline of ball is left on the hand.	Upon squeezing, no free water appears on the soil, but wet outline is left on the hand.	Upon squeezing, no free water appears on the soil,but wet outline of ball is left on the hand.

* Ball is formed by squeezing a handful of soil very firmly.

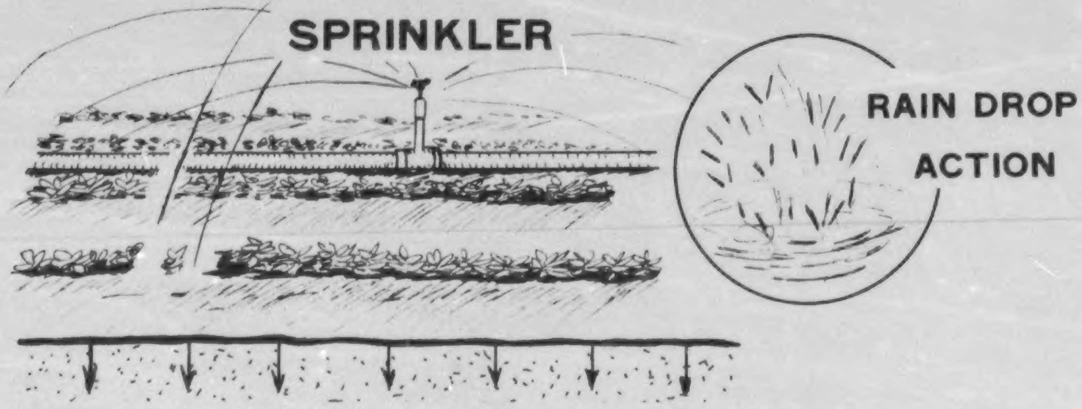
ACREAGE UNDER IRRIGATION



BY 1985 PROBABLE LOSS OF 840,000 ACRES OF IRRIGATED LAND IN TEXAS DUE TO DECLINING WATER TABLE.

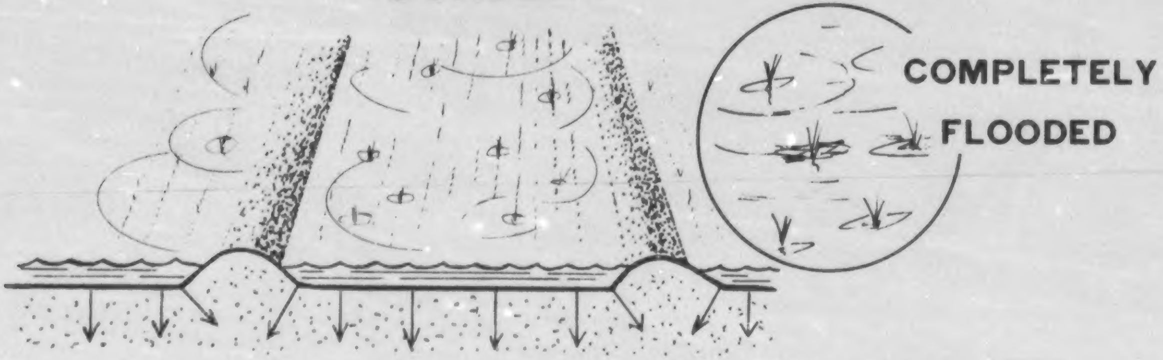
IRRIGATION METHODS

SPRINKLER


RAIN DROP
ACTION

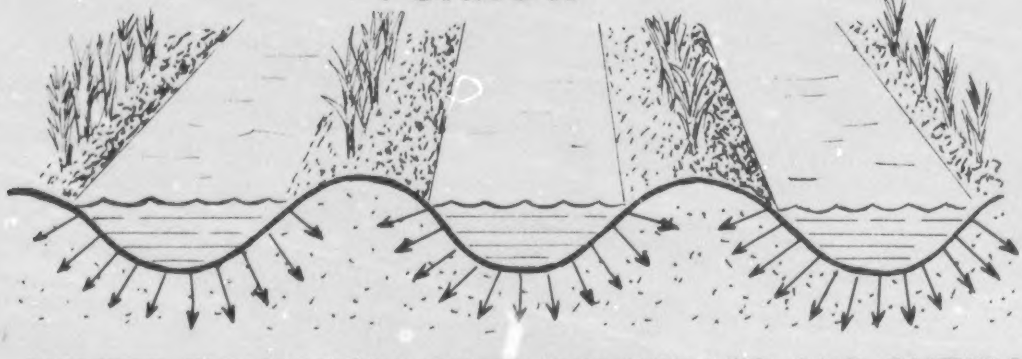
WATER MOVEMENT VERTICALLY DOWNWARD

BORDER


COMPLETELY
FLOODED

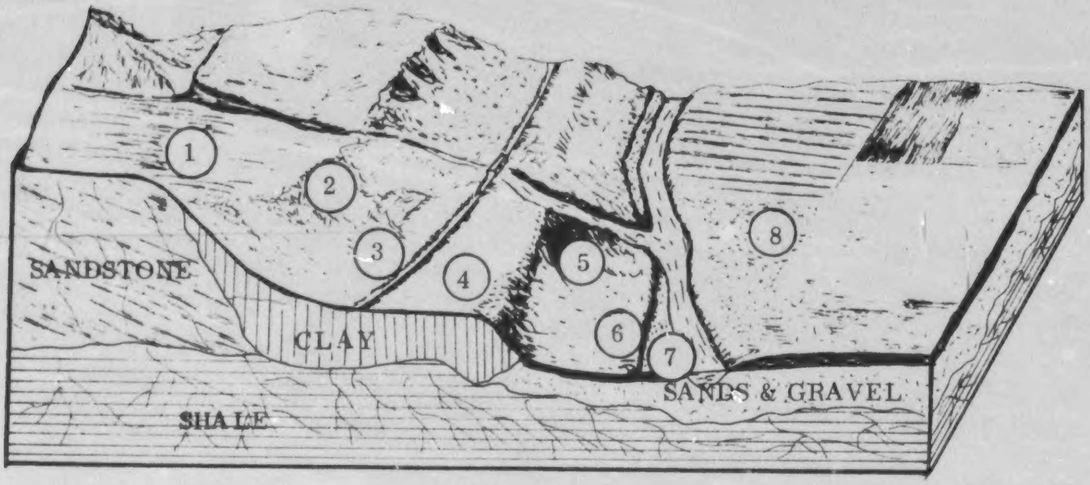
WATER MOVEMENT VERTICALLY DOWNWARD

FURROW

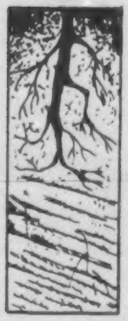


WATER MOVEMENT BOTH DOWNWARD AND OUTWARD

DEPTH AND LAYERING


1
2
3
8
SANDSTONE
5
4
6
7
CLAY
SANDS & GRAVEL
SHALE

①



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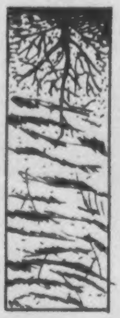

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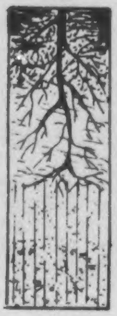

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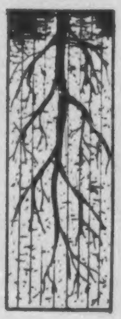

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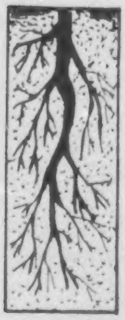

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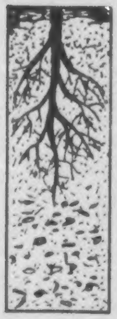

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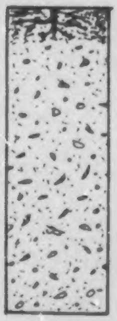

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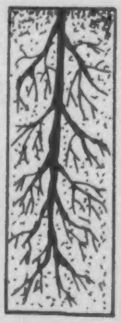
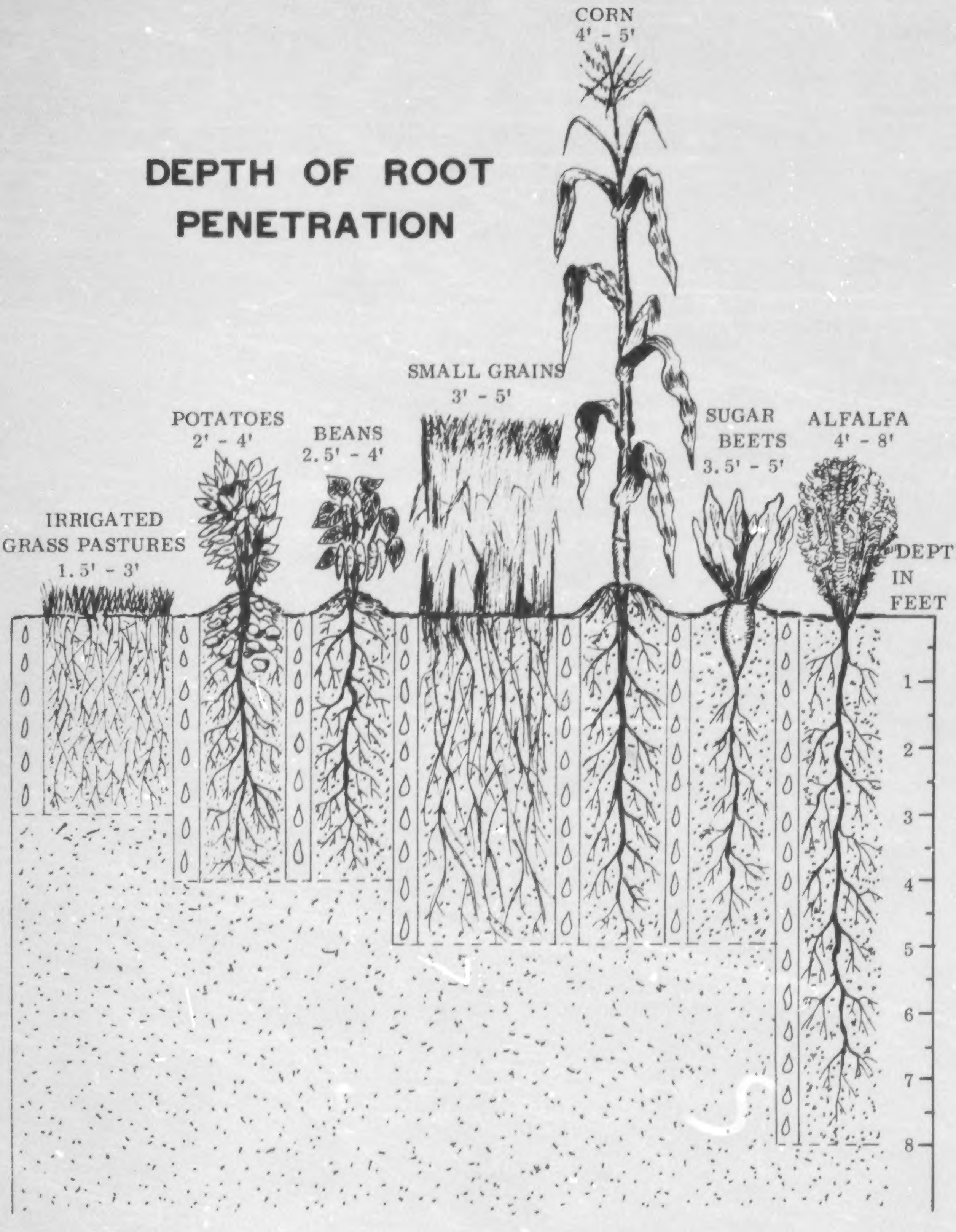
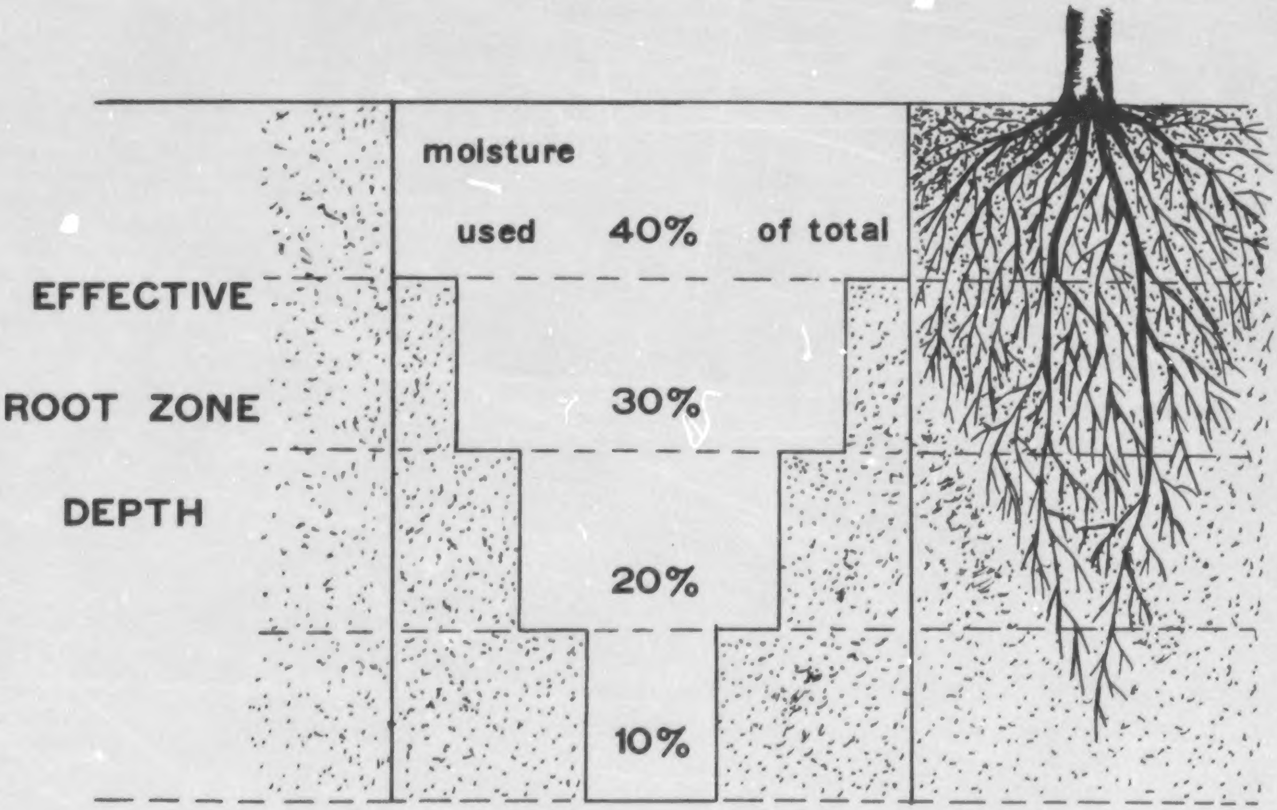


DEPTH OF ROOT PENETRATION


CORN
4' - 5'
SMALL GRAINS
3' - 5'
POTATOES
2' - 4'
BEANS
2.5' - 4'
SUGAR BEETS
3.5' - 5'
ALFALFA
4' - 8'
IRRIGATED GRASS PASTURES
1.5' - 3'
DEPTH IN FEET
1
2
3
4
5
6
7
8

PERCENT OF MOISTURE USED BY PLANT IN ROOT ZONE


moisture
used 40% of total
EFFECTIVE
ROOT ZONE
DEPTH
30%
20%
10%

Vocational Instructional Services
Agricultural Education

IV-F-1
Basic V. A. I
Agdex 016 x 100
25

PLANT SCIENCE

Unit F: Planting

Topic 1: Selection of Seed

Suggested Procedure and Activities: Transparencies of the seed labels may be helpful in the discussion. Also, labels from seed sacks may familiarize the student with how to read labels. Pure seed samples and seed samples containing foreign materials may be helpful.

1. Why it is Important to Select Good Seed

a. There is no substitute for seed that will produce both quantity and quality plants, fruit, and/or seed. The seed is like other organisms - it is the product of its parents and its environment, and it is the best known means of propagating plants.

b. It is considered advisable that the crop producer (farmer) use the necessary skills required to make a selection of high-quality seed. Money and time is not saved by purchasing cheap seed. The type of crop harvested depends largely upon the type of seed planted. Large producers of any one crop select seed that will give a maximum return for their investment.

Transparency No. 1

c. The following conditions exist when good seed are not selected:

Has low germination percentage
Has a large amount of inert matter (chaff, broken seed, and dirt particles)
Lacks resistance to diseases
Lacks resistance to insects
Lacks adaptability to certain climatic and growing conditions
Has a large amount of other crop seed
Infested with seed seed
Fails to remain viable from harvest to planting time

Transparency No. 2

d. The two types of weeds that should be avoided when selecting field crop seed are:

Primary noxious-weed seed include:

- Bindweed
- Nutgrass
- Blueweed
- Johnson grass
- Russian Knapgrass
- Wild onion
- Quackgrass
- Canada thistle
- Bermudagrass

Secondary noxious-weed seed include:

- Dodder
- Cocklebur
- Goatgrass
- Wild radish
- Red rice
- Wild carrot
- Chess
- Persian ryegrass
- Dock and sorrel
- Wild mustard
- Wild oats
- Buckhorn plantain
- Puncture vine
- Morning glory

2. The Major Characteristics of Good Seed

a. Good seed is viable (strong germination percentage), and it will produce fast growing seedlings. It is of more value to the producer because the possibility of getting a good stand is greater. Good seed will stay viable from the time they are harvested until they are planted the following season.

b. Good seed is considered pure. It is free of primary noxious-weed seed and it is practically free of all other seed and contains a minimum of inert material.

c. Good seed is well developed. The large seed have a tendency to produce their own type from the parent plant; therefore, larger yields are realized than from smaller seed. Large, plump, and well-developed seed contain more plant food to give the young plant a good start.

d. Good seed is considered free of disease. Diseases such as potato scab, grain smuts, and corn root rot are more expensive to destroy in the seed than buying disease-free seed. The great loss in using diseased seed is not found in the cost of the seed, but it is the enormous loss in the crop produced from the diseased seed.

e. Good seed will produce a maximum in quantity and quality, because it is adaptable to the climate and soil of the locality. It may be a variety that shows certain resistance to insects and diseases and has plant vigor that is lacking in other seed varieties. Good seed from varieties that have been tested locally should be selected.

f. Good seed is uniform in size and development. If inferior seed are mixed with good seed, large plants from the good seed will have a tendency to crowd out the inferior seed and may even mature at an earlier date. Large and small seed from the same plant usually carry the same hereditary characteristics, but the larger seed furnish a better start for the young plant due to more plant food being stored.

g. Good seed may be identified by the name it carries each year. The better known seed companies either grow or buy from reliable producers, and they label the varieties correctly each year.

3. Methods Used to Secure Good Seed

a. Home grown seed

The first planting should be from certified seed.

Select a clean ground and control weeds and insects throughout the production period.

Prevent seed from mixing with other seed at the gin and in the combine.

Store the dry seed in a dry, cool place if possible.

Treat the seed for disease and insects during storage and at planting time.

Test the seed for germination percentage before planting.

b. Purchasing certified seed from reliable dealers is a sure way of selecting quality seed for crop production. At least there is a better chance of selecting seed adaptable to the community and almost free of diseases and weeds. State seed laws have been established to protect both the buyer and the seed dealer. State seed laws conform to the Federal seed laws.

A seed label on the seed container give terms required by the state. There are four classes of certified seed used in the certified seed program in Texas. The classes are as follows:

Breeder Seed (White tag) - Breeder seed is used by the breeder to maintain the strain or variety. It is never for sale or used by the general public.

Foundation Seed (White tag) - Foundation seed shall be seed stocks so handled as to most nearly maintain specific genetic identity and purity and that may be distributed by an experiment station. It can be produced on a farm but under the supervision of an agronomist. Foundation seed shall be the source of registered seed.

Registered Seed (Purple tag) - Registered seed shall be so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. It shall be a class of seed suitable for the production of certified seed.

Certified seed (Blue tag) - Blue tag certified seed shall be the progeny of Foundation, Registered, or Certified seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. Green tag certified seed may be seed of the first year's increase from the blue tag or seed that fail to meet the registered requirements.

Transparencies Nos. 3, 4, and 5

c. Texas (unmixed seed) tags will have the following information:

- Commonly accepted name of:
  - Kind
  - Kind and variety or
  - Kind and type
- Lot number or other identification
- Percentage of purity
- Percentage of weed seed
- Percentage of inert matter
- Percentage of other agricultural seed
- Information on germination including percentage:
  - Germination, exclusive of hard seed
  - Hard seed
  - Month and year of test

d. Seed terms defined

Variety - Subdivision of a specie such as mustang oats.

Lot Number - Limited to 5000 bushels of seed. Seed of the same specie and variety grown in different fields but mixed to form a "lot."

Pure Seed - The percentage of seed that will produce plants true to variety and type.

Inert Matter - The percentage by weight of chaff, broken seed, stems, and soil particles.

Weed Seed - The percentage by weight of seed that are considered weeds.

Other Agricultural Crop Seed - The percentage by weight of seed not of the specified variety.

Germination - The percentage of seed that will produce normal plants under normal conditions.

Hard Seed - The percentage of seed which remain hard and sound at the end of a germination period.

Date of Test - The date the laboratory test was made on the seed.

Pure Live Seed - The amount of seed that when planted will produce plants.

4. Selecting Seed Samples for Testing

a. General Procedure

In order to secure a representative sample, equal portions should be taken from evenly distributed parts of the quantity of seed to be sampled. Access should be had to all parts of that quantity. When more than one trierful of seed is drawn from a bag, different paths should be followed. When more than one handful is taken from a bag, the handfuls should be taken from well-separated points.

For free-flowing seed in bags or bulk, a probe or trier should be used. For small free-flowing seed in bags, a probe or trier long enough to sample all portions of the bag should be used.

Non-free flowing seed such as certain grass seed or uncleaned seed, difficult to sample with a probe or trier, should be sampled by thrusting the hand into the bulk and withdrawing representative portions. The hand should be inserted in an open position and the fingers held closely together while the hand is being inserted and the portion withdrawn.

As the seed is sampled, each portion should be examined. If there appears to be a lack of uniformity, the portions should not be combined into a composite sample, but should be retained as separate samples.

When the portions appear to be uniform, they should be combined to form a composite sample.

b. Bulk Procedure

Bulk seed should be sampled by inserting a long probe or thrusting the hand into the bulk, as circumstances require, in at least seven uniformly distributed parts of the quantity being sampled. At least as many trierfuls or handfuls should be taken as the minimum which would be required for the same quantity of seed in bags of a size commonly used for such seed.

c. Bags Procedure

For lots of six bags or less, each bag should be sampled. A total of at least five trierfuls should be taken.

For lots of more than six bags, five bags plus at least ten percent of the number of bags in the lot should be sampled. Some persons prefer to sample every fifth bag but not less than five bags when the quantity is more than five bags. In any case, time should be given to drawing a representative sample from the lot.

d. Information to be given on sample.

Name and address of sender

Kind - Variety (if known)

Lot number or other stock identification

Year grown, month of harvest, and where grown

Test desired (whether purity only, germination only, or both)

Seed treatment (name of the seed treatment substance and the rate of application). As a protection for the personnel handling the seed, treated samples that do not give the name of the seed treatment substance will not be tested.

e. Forwarding samples

Samples should be mailed in cloth bags or strong cardboard containers. Paper bags and ice cream cartons are very unsatisfactory, usually bursting in transit.

Depending on your location, samples may be addressed to one of the following Texas Department of Agriculture Seed Laboratories:

Texas Department of Agriculture
Seed Laboratory
105 West Sixteenth Street
Austin, Texas 78701

Texas Department of Agriculture
Seed Laboratory
1924 34th Street
Lubbock, Texas 79411

Texas Department of Agriculture
Seed Laboratory
East College Street
Post Office Box 4625
Stephen F. Austin Station
Nacogdoches, Texas 75962

f. COST OF TESTING AGRICULTURAL SEED

Crop Seed	Complete Test	Purity Only	Germ. Only	Amount	Required Days
Alfalfa	2.50	1.50	1.00	5 oz.	7 days
Bermuda grass, Common	2.50	1.50	1.00	3 oz.	21 days
Corn	2.50	1.50	1.00	2 lbs.	7 days
Cotton	2.50	1.50	1.00	2 lbs.	12 days
Oats	2.50	1.50	1.00	2 lbs.	15 days
Okra	2.50	1.50	1.00	20 oz.	14 days
Rice	2.50	1.50	1.00	2 lbs.	14 days
Sorghum	2.50	1.50	1.00	1 lb.	10 days

5. Determining the Value of Pure Live Seed

a. Using the prices and labels from two different lots of Common Bermuda grass (Hulled) seed, the better seed can be selected by the number of pounds of Pure Live Seed that are in each lot and the cost per pound of each lot. For example, which of the following lots should be selected:

Lot I		Lot II	
Germination	85.00%	Germination	80.00%
Inert Matter	1.33%	Inert Matter	2.45%
Weed Seed	.02%	Weed Seed	.02%
Other Crop Seed	2.78%	Other Crop Seed	3.78%

To determine the purity content:

Lot I		Lot II	
Inert Matter	1.33%	Inert Matter	2.45%
Weed Seed	.02%	Weed Seed	.02%
Other Crop Seed	2.78%	Other Crop Seed	3.78%
Non Purities	4.13%	Non Purities	6.25%

Lot I	Lot II
100.00%	100.00%
- 4.13%	- 6.25%
95.87% Pure Seed	93.75% Pure Seed

Lot I is $65.00 per hundred. Lot II is $62.00 per hundred.

The following formula can be used to determine the value of the different lots.

$$\frac{\text{Price per unit}}{\text{Purity\% x germination\%}} \quad \text{price paid per hundred pounds of pure live seed}$$

Lot I

$$\frac{\text{cost per hundred \$65.00}}{\text{purity 95.87\% x germination 85\%}} - \begin{array}{l}\text{cost of live seed} \\ \text{\$ 80.24 per hundred pounds}\end{array}$$

Lot II

$$\frac{\text{cost per hundred \$63.00}}{\text{purity 93.75 x germination 80\%}} - \begin{array}{l}\text{cost of live seed \$84.00} \\ \text{per hundred}\end{array}$$

The seed cost of Lot II is more expensive for pure seed, even though the price per hundred weight is slightly lower than Lot I. Before buying seed the seed label should be studied. It is the "key" to the best seed buy.

References:

1. Hughes, Harold D. and Edwin R. Henson, *Crop Production Principles and Practices*, the Macmillan Company, New York, NY, 1967.

2. Janick, Jules and others, *Plant Science: An Introduction to World Crops*, W. H. Freeman and Company, New York, NY, 1969.

3. Klingman, Glenn C., *Crop Production in the South*, John Wiley and Sons., Inc. New York, NY, 1967.

4. Martin, John H. and Warren H. Leonard, *Principles of Crop Production*, The Macmillan Company, New York, NY, 1965.

5. "Seed Trade Buyers Guide," Fifty-First Edition, Volume 41, LaGrange, IL, 1968.

LOSSES REALIZED WHEN GOOD SEED IS NOT SELECTED

1. LOW GERMINATION PERCENTAGE
2. CONTAINS LARGE AMOUNT OF INERT MATTER
3. SUBJECT TO DISEASES
4. SUBJECT TO INSECTS
5. NOT ADAPTABLE TO CLIMATIC AND GROWING CONDITIONS
6. CONTAINS A LARGE AMOUNT OF OTHER CROP SEED
7. CONTAINS A LARGE AMOUNT OF WEED SEED

PRIMARY NOXIOUS WEED SEED

- BINDWEED
- NUTGRASS
- BLUEWEED
- QUACKGRASS
- WILD ONION
- RUSSIAN KNAPGRASS
- JOHNSON GRASS
- CANADA THISTLE
- BERMUDA GRASS

SECONDARY NOXIOUS WEED SEED

- COCKLEBUR
- GOATGRASS
- WILD MUSTARD
- DOCK AND SORREL
- PUNCTURE VINE
- WILD CARROT
- PERSIAN RYEGRASS
- DODDER
- WILD RADISH
- RED RICE
- WILD OATS
- MORNING GLORY
- CHESS
- BUCKHORN PLANTAIN

TEXAS SEED LABEL — BACK SIDE

LOT NO. A8297H NET WT. 50#

GROWN ARIZ. TESTED 12– 73

KIND COMMON BERMUDAGRASS (HULLED)

GERMINATION 85%

PURE SEED	95.87%
INERT MATTER	1.33%
OTHER CROP	2.78%
WEED SEED	.02%
NOXIOUS WEED SEED PER LB.	NONE

OUT-OF-STATE SEED LABEL — BACK SIDE

KIND VARIETY LOT NO.

ORIGIN

PURITY % WEEDSEED % INERT MATTER %

OTHER CROP SEED % GERM. DATE

GERMINATION % HARD SEED %

NAME AND NO. NOXIOUS WEEDS PER OZ.

VENDOR

ADDRESS

TEXAS TESTED SEED LABEL

STATE DEPARTMENT OF AGRICULTURE
SEED LABORATORY
AUSTIN, TEXAS

NOTICE

THIS SEED LABEL HAS BEEN ISSUED BY THE TEXAS STATE DEPARTMENT OF AGRICULTURE UNDER AUTHORITY OF THE TEXAS SEED LAW AND EVIDENCES THE PAYMENT OF THE REQUIRED TESTED SEED LABEL TAX.

EACH BAG OF SEED OFFERED OR EXPOSED FOR SALE IN TEXAS FOR PLANTING PURPOSES MUST HAVE THE TESTED SEED LABEL ATTACHED. THE VENDOR'S STATEMENT OF ANALYSIS IS GIVEN ON THE REVERSE SIDE OF THIS TAG & MUST BE FILLED OUT IN DETAIL. BUYER SHOULD KEEP ALL TAGS, A SAMPLE OF SEED, INVOICES, ETC., FOR FUTURE REFERENCE.

JOHN C. WHITE
COMMISSIONER OF AGRICULTURE

SEED LABEL — FRONT SIDE

Vocational Instructional Services
Agricultural Education

IV-F-2
Basic V. A. 1
Agdex 016 x $\frac{106}{22}$

PLANT SCIENCE

Unit F: Planting

Topic 2: Equipment and Methods Used in Planting - Seeding Rates and Spacing

Suggested Procedures and Activities: The transparencies and tables may be of value in presenting the lesson.

1. Early Development of the Different Types of Planting Equipment

a. Seed have been placed in the soil in many ways. Early man planted his grain crops by making mounds or small hills of soil and burying the seed in the mound center; by plowing the soil with a wood plow and punching holes with a sharp stick and dropping a few seed in each hole; by dropping seed in the furrow made by a wooden plow; or by transplanting plants by hand from a crude seedbed.

b. The first planter was developed in the United States at the beginning of the nineteenth century. A grain drill was patented in 1799. The first cotton planter patented in 1825, and the first corn planter was patented in 1839. By 1880, over 50 percent of the wheat crop was sown by grain drills. In 1923, the tricycle type tractor began to appear on farms. Planter and fertilizer attachments were made available as tractor equipment for the first time during the same year.

2. Types of Planting Equipment

a. Row-crop planters are used to plant the major row crops such as cotton, sorghum, corn, peas, beans, vegetables, and potatoes. Some of the functions of row-crop planters are; plant more than one type of seed, seed accurately planted at a moderate to fast speed, sow seed at a uniform depth, plant at different row spacings, and apply fertilizer, insecticides, and herbicides. The most common sizes of these planters are two, four, six, and eight row. A six-row planter will plant 30 to 35 percent more acreage than a four-row planter if both travel at the same rate of speed. Planter size is usually determined by the amount of acreage to be planted in any one season.

Most planters can be adjusted to desired row width. If conventional row-crop harvesters are used, the width of crop row must be adjusted at planting time to equal the harvester row width. Row width adjustment is considered routine, but changing narrow row crop planter equipment can be a seasonal problem if special attachments are used.

Trailing type and tractor mounted planters are divided into three classes.

Drill Planters - The drill planter places the seed evenly in seedbeds. Seed fall from the seed plate to the ground. Spacing of seed is regulated by the relation of the seed plate speed and the ground speed. The major parts of this type of planter are a hopper, metering device, seed tube, furrow opener, and a covering device. Drill planters may operate with fertilizer plant pest attachments. They are not equipped with parts needed for checking.

Hill-Drop Planters - This planter is constructed to collect seed and drop them in hills at regular intervals in the row. Some hill-drop planters can be adjusted to drill, and they can be used to check plant if equipment with the check-row attachment. The parts are: seed hopper, metering device, valve system to collect seed, furrow opener, and a covering device.

Check-Row Planters - This planter is constructed with valves and checkheads to collect seed and drop them at the same place in each row so that the plants may be cultivated both with the original rows and across the rows. The valves may be locked open as in the hill-drop planter so that the seed may be drilled along the row.

b. Other types of planting equipment include:

Transparency No. 1

Endgate Seeder - The endgate is usually mounted on the power-take-off of a tractor. The ribs throw the seed out the back sides in a steady stream.

Knapsack Seeder - Seeds are thrown from ribs from the front and sides as the crank revolves the ribbed wheel. It is slung over the shoulders by straps.

Airplane - The airplane is used to broadcast clovers, rice, and grass seeds. Its seeding attachments are designed to spread (broadcast) seed over a wide area.

Two Wheel Weeder-Mulcher - Seeds are dropped on the ground from the hopper and covered by the mulcher fingers.

Transparency No. 2

Grain Drills - There are two types of grain drills; the trailing and tractor mounted. Usually each wheel on the trailing drill drives one-half of the drill feeds. They plant the seed in narrow rows at the same depth. A 12-6 drill has twelve row openers six inches apart. The drill may have fertilizer hoppers mounted on the equipment.

3. Types of Plates Used in Planter Hoppers

Transparency No. 3

a. The heart of the field crop planter is the seed plate. Each plate is made for a certain type and size of seed. Plate cells may be round, oblong, or oval. For example, there are three different plates used for corn, but there are several cell sizes due to the size of grain. The plates are:

The edge-drop plate carries kernels of corn on the edge around the outer part of the plate.

The flat-drop plate carries the kernel in the flat position around the outer edge of the plate.

The full-hill plate carries three or four kernels per cell in the edge of the plate.

Transparency No. 4

b. Planters are equipped with certain types of furrow openers. The variable-depth opener is used for cotton; the curved runner opener for cotton and corn; the single disk opener for stony and trash soil; the curved double disk opener for trashy soil; and the colter double disk opener for soil that is not too trashy.

c. Furrow covers are of many types. The open center press wheel is most commonly used. Other types of covers are: rubber-tired press wheels, zero-pressure rubber tires, disk covers, blade covers, shovels, and knife covers.

Transparency No. 5

4. Methods of Planting

a. The methods of planting depend upon the following conditions: rainfall, soil drainage, soil moisture-holding capacity, soil temperature, fertilizer use, and weed control. Due to these different conditions, seed are sown on three different levels.

Bed planting seed are planted on beds that have been made by a lister. In high rainfall areas the elevated beds provide drainage for the seed.

Flat planting may conserve more of the soil moisture than planting on elevated seed beds. It is practiced in semi-arid regions.

Bottom-of-furrow planting is usually practiced in semi-arid regions where there is a need to protect the small plant against a lack of moisture and strong wind.

Blackland planting is usually done on beds after the bed is disked or cultivated to remove weeds. In blackland areas the land is bedded in time for it to settle before planting, which is several weeks or even months before planting season.

Table No. 1

b. The quantity of seed and the spacing of crop plants per acre is to obtain the maximum yield and maintain the quality of the product. The amount of seed planted per acre varies according to whether or not the land is irrigated or dry land, fertile or infertile soil, short or long season crops, and use of the crops.

The rate, spacing, and method of seeding a field crop does not happen by chance. Each of the practices have been approved for each locality by years of experience.

Table No. 2

c. Soil condition is one of the major factors in determining the depth of plant. The factors that determine depth to plant are:

Soil Texture - Seed can be planted deeper in sandy soil than clay soil.

Soil Temperature - Seed can be planted deeper in warm soil than cold soil.

Soil Moisture - Seed are usually planted deeper in dry soil than wet soil.

Plant Structure - Peas can be planted deeper than beans because their cotyledons remain below the soil. Bean cotyledons must emerge from the soil. Large seed will emerge from a greater depth than small seed.

d. Germination may be considered a heredity characteristic, but temperature, moisture, and oxygen also affect the length of time it takes different seed to germinate.

5. Planting and Harvesting Dates of Crops and the Areas Where They are Produced

a. There are two major climatic factors that determine the dates that crops are planted. They are temperature and rainfall. Both of these factors also control the growing season in many localities. An additional important factor in the life of a plant is its heredity characteristics. A cool weather plant (wheat) will withstand low temperatures, whereas a warm weather plant (cotton) requires high temperatures.

Table No. 3

Table 3 gives the usual planting and harvesting dates. The Texas Crops Reporting District may be used to locate the areas and counties where the principal crops are produced. (Use Transparency No. 1, IV-A-2.)

References:

1. Martin, John H. and Warren H. Leonard, Principles of Field Crop Production, The Macmillan Company, New York, NY, 1969.

2. Smith, Harris Pearson, Farm Machinery and Equipment, McGraw-Hill Book Company, Inc., New York, NY, 1965.

3. "Field and Seed Crops, Usual Planting and Harvesting Dates," United States Department of Agriculture, Agriculture Handbook No. 283, Washington, D.C., 1965.

4. "Seed Production of Some Common Field Crops," Department of Agricultural Education, Ohio State University, Columbus, OH, 1966.

RATES, SPACE, AND METHODS OF SEEDING CROPS

Table I

Crop	Rate of Planting Per Acre	Seeding Space	Method of Seeding
Alfalfa	15 to 25 lbs.	Drill or Broadcast	Drill, Seeder, Hand
Bermudagrass	5 lbs.	Broadcast	Seeder, Hand
Coastal Bermudagrass	12 to 20 bu. sprigs	4 to 10 inches	Sprigger, Hand
Corn	6 to 12 lbs.	10 to 13 inches.	Rows - 34" to 42"
Cotton	1 bu. (32 lbs.)	3 Plants per foot	Rows - 36" to 48"
Cowpeas	1/2 to 3/4 bu. (bu. - 60 lbs.)	2 to 4 inches	Rows - 18" to 36"
Oats	2 to 3 bu. (bu. - 32 lbs.)	Drill or Broadcast	Drill or Broadcast
Peanuts	25 to 50 lbs.	4 to 6 inches	Rows - 28" to 30"
Redtop	3 to 5 lbs.	Broadcast	Drill or Broadcast
Grain Sorghum	7 to 8 lbs.	4 to 6 inches	Rows - 36" to 42"
Sweet Sorghum	8 to 10 lbs.	4 to 6 inches	Rows - 36" to 42"
Soybeans	25 to 35 lbs. (60 lbs. - 1 bu.)	Broadcast or Rows	Broadcast or Rows
Sudangrass	20 to 30 lbs.	Drill, Seeder, Hand	Drill or Broadcast
Wheat	60 to 120 lbs. (60 lbs. - 1 bu.)	Drill	Drill
Barley	72 to 96 lbs. (48 lbs. - 1 bu.)	Drill	Drill
Rice	90 to 100 lbs.	Drill	Drill

DEPTH TO PLANT AND GERMINATION PERIOD

Table II

Crop	Average Planting Depth - Inches	Days Required for Germination
Alfalfa	1/4 to 3/4	4-7
Bermudagrass	1/4 to 1/2	7-21
Corn	1 to 3	4-7
Cotton	1 to 3	4-12
Cowpeas	1 to 3	6-8
Oats	1 to 2	5-10
Peanuts	1 to 2	6-12
Redtop	3/4 to 1	8-10
Grain Sorghum	1 to 2	8-10
Sweet Sorghum	1 to 2	8-10
Soybeans	1 to 2	5-8
Sudangrass	3/4 to 1-1/2	8-10
Wheat	1 to 2	3-7
Barley	1 to 2	3-7
Rice	On surface in Water or about 1 inch by drill	12-14

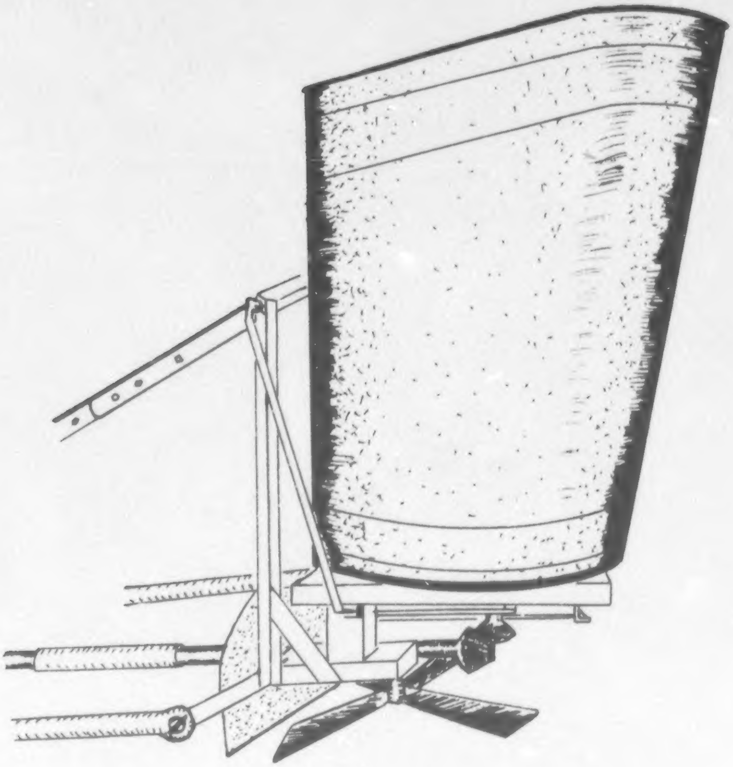
Crops are usually planted shallow in clay soils and deep in sandy soils. Temperature, moisture, and oxygen affect the rate of germination.

USUAL PLANTING AND HARVESTING DATES BY CROPS AND PRINCIPAL PRODUCING AREAS

Table III

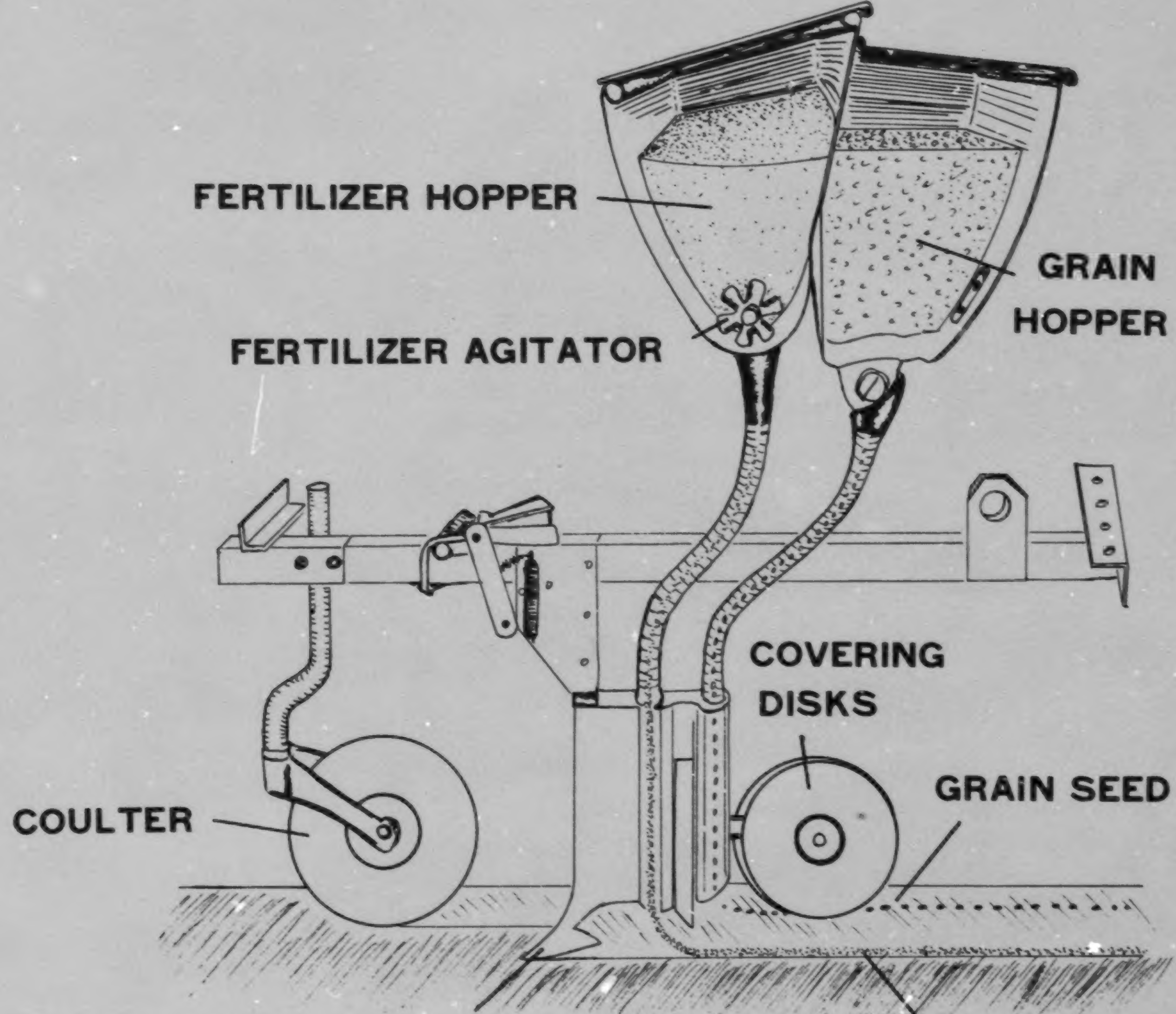
Crop	Usual Planting Dates	Usual Harvesting Dates Begins	Usual Harvesting Dates Ends	Principal Producing Areas & Counties
Barley	Sept. 10-Nov. 25	May 15	June 30	1n, 2n, 2s, 4
Broomcorn	Mar. 10-Apr. 25	June 25	July 25	Bee, Medina, Karnes, Live Oak, LaSalle
Corn, Grain	Mar. 5-May 10	Aug. 5	Oct. 20	4, 5n, 8n, 9
Silage	Mar. 5-May 10	June 10	Aug. 20	1n, 4, 8n
Forage	Mar. 5-May 10	June 20	Aug. 5	4, 8n, 9
Cotton	Mar. 10-June 15	July 25	Jan. 10	Statewide
Cowpeas for Peas	Mar. 15-June 20	May 25	Aug. 20	1s, 3, 4, 5n, 5a, 10n
Flaxseed	Nov. 1-Dec. 20	May 1	June 10	8n, 8s, 10n
Hay, Alfalfa,		May 1	Sept. 30	1n, 2n, 4, 6, 9
Wild		June 10	Sept. 25	Statewide
Oats	Sept. 10-Nov. 25	May 10	June 25	2s, 3, 4, 7, 8n
Peanuts for Nuts	Apr. 1-Aug. 1	July 15	Dec. 15	3, 4, 8n, 10n
Popcorn	Apr. 1-May 1	July 20	Sept. 1	Lamar, Fannin, Guadalupe
Rice	Mar. 25-June 1	July 15	Nov. 15	9
Rye	Sept. 1-Nov. 20	May 10	June 25	1n, 1s, 2n, 2s
Sorghum, Grain	Mar. 10-July 1	July 1	Dec. 1	Statewide
Silage	Mar. 10-July 1	June 10	Aug. 20	Statewide
Soybeans	June 5-July 10	Oct. 20	Dec. 25	1n, 1s, 5n
Wheat, Winter	Sept. 1-Nov. 20	May 25	July 5	1n, 2n, 2s, 4
SEED CROPS:				
Alfalfa		Aug. 1	Sept. 30	2n, 6
Sweetclover		July 1	Aug. 10	4, 5n, 8n
Sudangrass		Aug. 25	Nov. 25	1n, 1s
Hairy Vetch		May 25	July 5	4, 5n

POWER — DRIVE SEEDER
(BROADCAST)



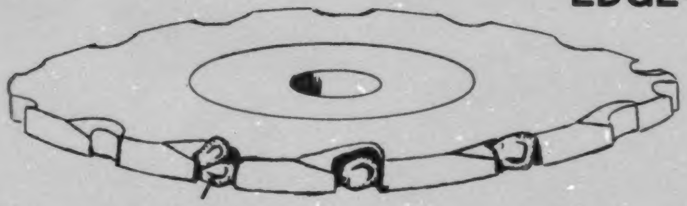
OPERATED FROM POWER—TAKE—OFF. OPERATES SIMILAR TO KNAPSACK BROADCAST SEEDER.

SYSTEM OF PLANTING WITH GRAIN DRILL


FERTILIZER HOPPER
GRAIN HOPPER
FERTILIZER AGITATOR
COVERING DISKS
GRAIN SEED
COULTER
CHISEL FURROW OPENER
FERTILIZER

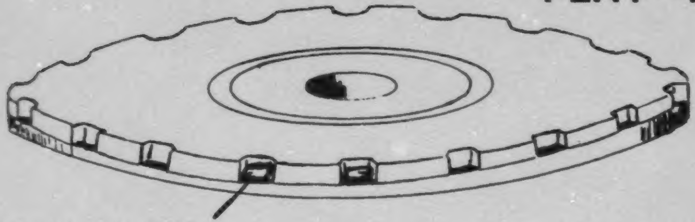
CORN SEED PLATES

EDGE–DROP PLATE



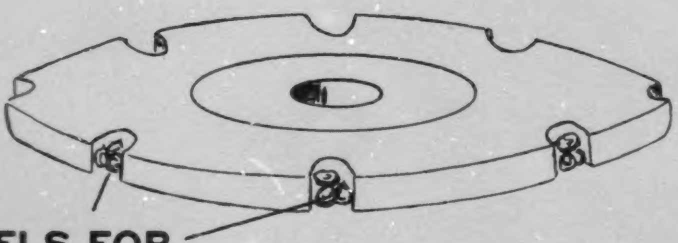
CORN KERNEL ON EDGE

FLAT–DROP PLATE



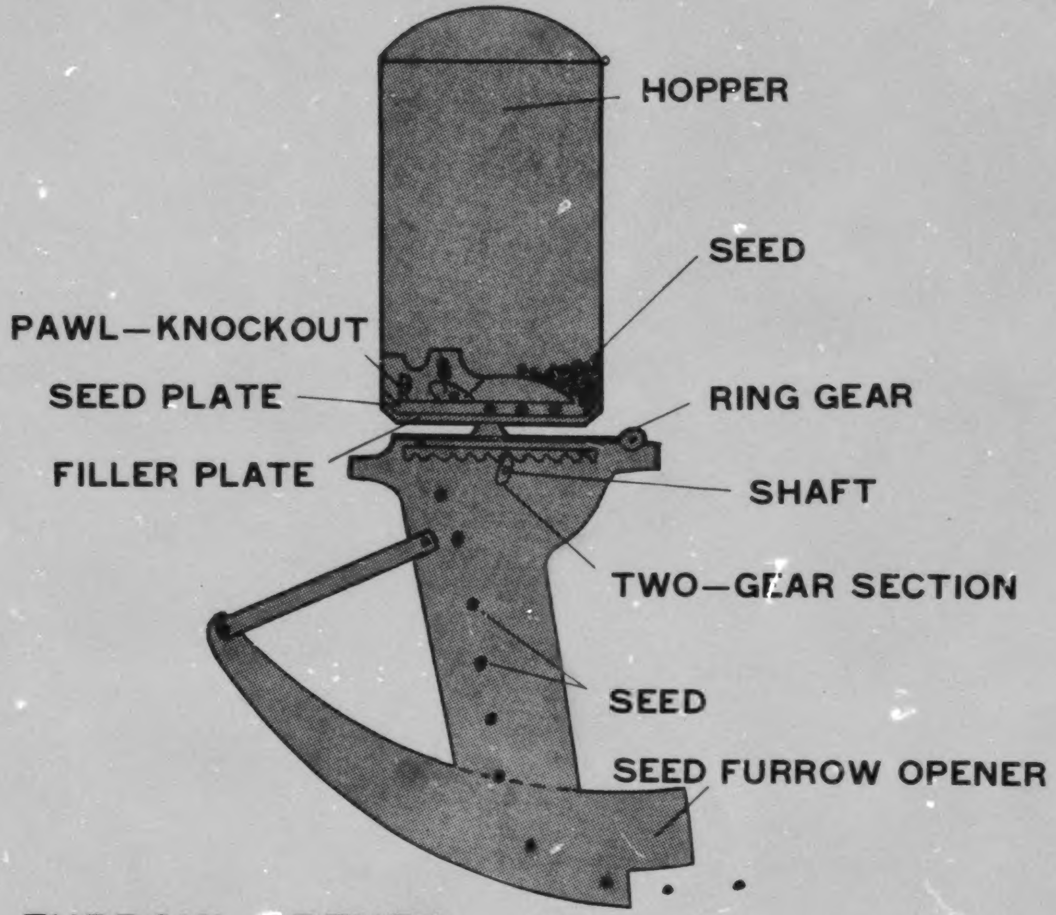
CORN KERNEL FLAT

FULL–HILL DROP PLATE

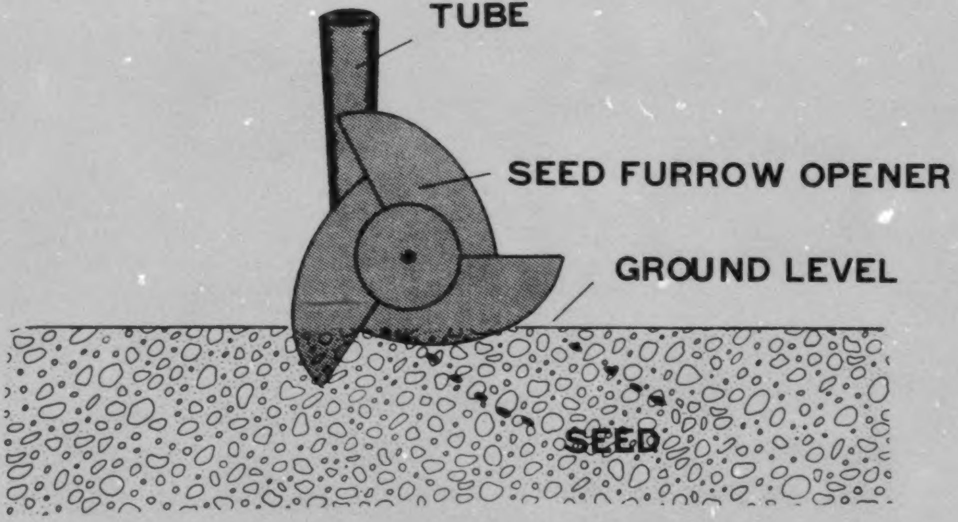


CORN KERNELS FOR
HILL PLANTING

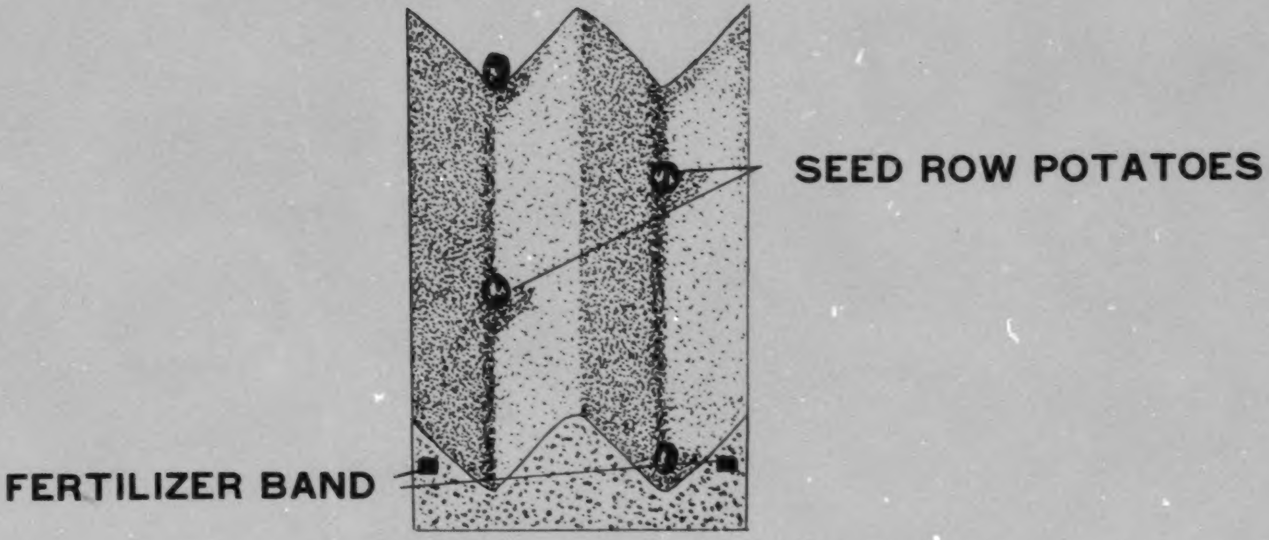
SEEDING PARTS OF A PLANTER


HOPPER
SEED
PAWL—KNOCKOUT
SEED PLATE
RING GEAR
FILLER PLATE
SHAFT
TWO—GEAR SECTION
SEED
SEED FURROW OPENER

FURROW OPENER

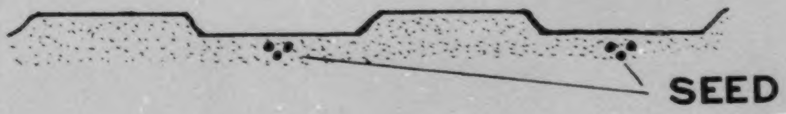

TUBE
SEED FURROW OPENER
GROUND LEVEL
SEED

ONE METHOD OF POTATO PLANTING


SEED ROW POTATOES
FERTILIZER BAND

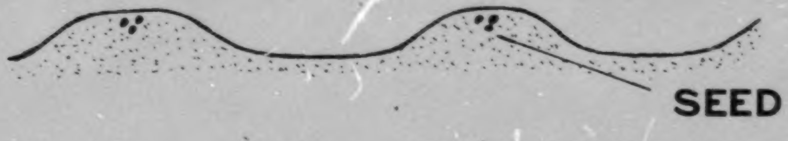
THREE WAYS TO PLANT SEED

SURFACE PLANTING



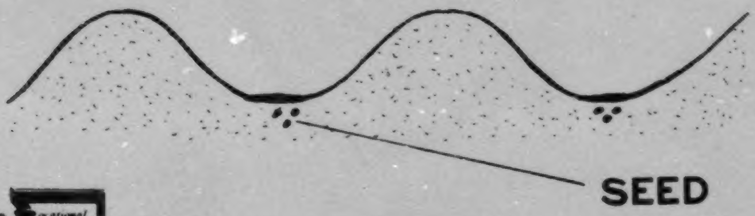
MADE BY DISK HARROW

ON TOP OF BED PLANTING



MADE BY LISTER

FURROW PLANTING



MADE BY LISTER

ECONOMIC IMPORTANCE AND MAJOR AREAS OF CROP PRODUCTION

Crop husbandry began about ten thousand years ago when the first seed was planted and the first animal domesticated. Before plants and animals were domesticated there was little control over a continuous and adequate supply of food and clothing. The early individual existed as a nomadic hunter while wandering over the earth in search of food and clothing.

About 10,000 years ago hand-labor cultivation began in the middle East. The early agriculturist had to draw upon wild plants and animals in order to develop major food plants and major animal breeds that are prevalent today. Agriculture spread from the middle East to the western and northern shores of the Black Sea; then to the Valley of the Indies in eastern India and to northern China. The growth and development of early agriculture in the Western Hemisphere has been considered independent of agriculture and development in the eastern part of the world. Crop production was considered a highly developed art at the time it appeared in Egyptian, Greek, and Roman writings.

The First Crops of Importance in the World

Two varieties of wheat and barley were discovered in Iraq that indicated it had been grown seven thousand years ago. Both wheat and barley were developed in southwestern Asia. Wheat was first grown in Massachusetts in 1602.

Fossilized corn pollen said to be 60,000 years old has been discovered below Mexico City. Small corn cobs thought to be 6,000 years old were found in a cave in New Mexico. Corn and potatoes were among the major cultivated plants discovered in the New World.

Rice was used extensively as a cereal in China by 2800 B.C. There are several wild species of it in southeast Asia; it is thought to have been developed in Asia. Rice was successfully grown in the New World for the first time in 1685, in the Carolinas.

Cotton, the king of fibers, was developed before the first century. In 1929, cotton fibers that dated back to 3000 B.C. were found in Pakistan. Cotton was grown in India about 5,000 years ago. When Columbus discovered the New World (1492) he found both cotton and tobacco being used by the natives.

Sorghums originated as a cultivated plant in Africa thousands of years ago. Grain sorghum was developed in Africa, China, and India as a human food. It was developed in the United States mainly as a feed for livestock and poultry.

Land Use

Only 7.7 percent of the earth's surface is adaptable to cultivation, and most of this type of land is in production. However, many millions of acres of arable land is continuing to be taken out of cultivation for expanding city population use, building of large water storage areas, and interstate roads.

All the food and fiber crops in the United States (50 states) is produced on 324,808,000 acres of cropland. The 32 major crops in Texas were produced on 19,684,000 acres. The 1970 census reported 2,730,242 farms in the United States. These farms totaled 1,066,216,650 acres in the 50 states. Texas total land area is about 168 million acres. About 2,880,000 acres are covered in inland water which leaves about 165,120,000 acres of actual land area. The total land area in the United States is 1.9 billion acres.

Crop cash receipts amounted to $2,928,135,000 in Texas alone during the 1974 crop year. Crop receipts for all states in the United States totaled $46,661,480,000 in 1975.

Some principal crops grown in Texas and their approximate total value in thousands of dollars:

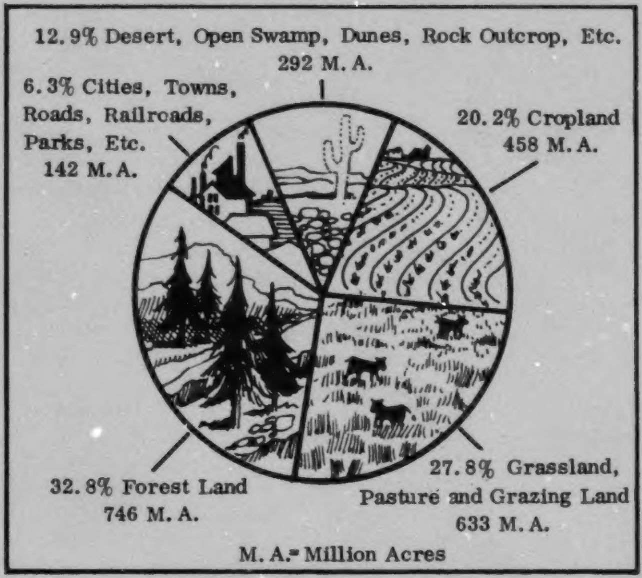
Cotton (Lint upland)	$449,712
Grain Sorghum	926,640
Wheat (Winter)	205,920
Rice	277,838
Corn	250,240
Oats	12,150
Barley	2,700
Rye	450
Peanuts	72,035
Cottonseed	122,280
Flaxseed	2,936
Soybeans	57,942
Cow Peas (Dry)	1,515
Sugarcane	53,100
Sugarbeets	12,520
Hays (All)	245,088
Vegetables (Commercial, all)	142,272
Citrus Fruit	281,900
Peaches	2,880
Pecans	16,055
Sweetpotatoes	6,825
Potatoes (Irish)	29,160

Major Uses of Land

The total United States acreage in the 50 states is 2,271,000,000 acres.

Importance of the Crop Plant

Each individual and domesticated animal has always depended upon the plant as an important source of food supply. The



past and present experiences with plants are:

People have used more than 3,000 species of plants since domesticating crops for food and fiber.

Today farmers cultivate about 150 species of plants to produce both food and fiber. However, only about 12 major crop plants are used for food, feed, and clothing.

Major Crop Plant Classes
Used as a Source of Food Supply

Cereals (rice, wheat, and corn)
Sugar Plants (sugarcane and sugarbeets)
Root Crops (potatoes, sweetpotatoes, and cassava)
Tree Crops (bananas and coconuts)
Oilseed Legumes (soybeans and peanuts)
Oilseed - Other (cottonseed and African palm)
Pulses (dry beans, chic peas, and broadbeans)

Uses and Processing Areas of Major Crop Plants

Rice leads all other crops as a basic food. Over one-half of the world's population (more than one and one-half billion people) depend on rice as a basic cereal.

The average annual per capita consumption of rice in the U. S. is about 7 pounds. In the Orient the consumption is between 200 to 400 pounds. Good quality rice is used for food. The bran layer and germ are used as livestock feed.

The major rice milling areas are: Japan, China, India, Near East, and Western part of the Western Hemisphere (North and South America) including the United States.

Sorghum is considered a livestock feed crop in the U. S. In many Asiatic and African countries 75 percent of the acreage is devoted to grain sorghum for food purposes.

The U. S. uses grain sorghum in the following ways: livestock and poultry feed; to make alcohol, flour for wallboard, glue, tapioca, and oil.

Corn is considered a livestock feed in the U. S. because about 90 percent is fed to livestock and 10 percent is used to provide food for human consumption.

About 33 pounds of corn is consumed annually by each individual in the U. S.

Corn products used by the individual include: chemicals, syrup, oil, starch, sugar, alcohol, cereals, and meal.

Corn is grown and processed in Africa, South America, Mexico, Europe, and parts of Asia.

The largest producer and processor of this special crop is the U. S.

Wheat is considered the most important food crop in the United States and Europe. Unlike corn, it is used for food, instead of being fed to livestock. The average wheat consumption per person in the U. S. is about 110 pounds per year.

Nearly all the wheat in the world is made into flour. The yield of flour is 70 to 75 percent of the total grain weight.

By-products of flour milling include: bran, middlings, and shorts.

Wheat is used to make sugar, alcohol, germ oil, and breakfast cereal.

The major wheat processing countries are: United States, Canada, Russia, Australia, Europe, and Argentina. Countries such as India, China, Egypt, and Northern Africa use wheat as a basic food even though they are not considered major producers.

Barley, oats, and rye are used mainly for livestock grazing and hay.

Barley is considered an excellent livestock feed except when fed alone to horses. If fed alone, it may cause colic.

Malt is one of the major uses of barley grain. Malt sprouts or distiller's grain, a by-product of the brewing industry, is used in dairy feeds.

Oats are used as a superior feed for horses, breeding animals, and young livestock. About four percent of all oats produced in the U. S. are used as food for human consumption.

Rye is used mainly to make alcohol and flour. Some 40 percent of rye acreage is used to produce grain.

Rye straw is very useful in the manufacture of paper.

Barley, oats, and rye are processed and used mainly as a livestock feed in the United States, Russia, Canada, and Europe.

Soybeans, cottonseed, and peanuts are considered major oil crops of the world.

There are about 15 industrial uses, 12 human food uses, and five livestock uses of soybeans.

Soybeans are used to make soaps, plastics, paints, lubricants, flour, oils, meal, and cake.

The U. S. is the largest producer and processor, with 38% of the world production. China, Manchuria, Korea, and Japan are also large producers and processors.

Cottonseed is the second most important oil crop in the U. S. and the world.

The many uses are: soaps, cosmetics, paintbase, linoleum, oleo - margarine, cooking oil, cottonseed cake, and meal.

The United States is the largest processor of cottonseed

in the world. South America, Central America, Egypt, and Australia also process large quantities to extract the oil.
Peanuts are processed mainly for oil and meal. Peanut oil is used in a similar way as soybean and cottonseed oil, that is, for human consumption. Peanut meal is also used similarly to soybean and cottonseed meal - as a livestock feed.

Irish potatoes are recognized as an important food crop in the U. S. The average per capita consumption annually is 117 pounds.

About 60 percent of the potato is consumed as a table food. Some 23 percent is processed for human consumption and only about three percent is used in livestock feeds.
Irish potatoes are also grown and processed in Canada, South America, Europe, and Russia.

Tobacco is used in many different ways. Some of these ways are: cigarettes, cigars, pipe, chewing, dipping (powder or dust form); and as a toxic alkaloid, nicotine, which is used as an insecticide.

The annual per capita consumption is 11.3 pounds.
Leading countries that manufacture tobacco products are: United States, China, India, Russia, Brazil, Turkey, Pakistan, and Japan.

Cotton is produced mainly for fiber. Almost 40 percent of the world's cotton is produced in the United States. As mentioned above, cottonseed is a very important oil crop.

Processing factories are located in many countries of the world. Large spinning and weaving factories are located in Japan, Western Europe, India, Korea, and in several South American countries.
Other than cloth, cotton products are used in making explosives, plastics, rayon, paints, paper, and different types of furniture.
The annual per capita consumption of cotton (lint) in the U. S. is 23.5 pounds.
Other leading cotton producing countries include: Brazil, Russia, India, China, and Egypt.

Sugarbeets and sugarcane are crops used to produce sugar. The annual per capita consumption in the U. S. is 97 pounds.

Several uses of sugar from the two sugar producing crops are: sweeteners, making syrups, processing fruits, making beverages. making pastries, making candies, and processing certain dairy products.
Many Central American, South American, and Caribbean countries send crude sugar to the U. S. for refining.
Sugar mills are located in the United States, South America, Central America, the Caribbean, Africa, and the Far East.

Annual Per Capita Consumption of Food

The average per capita consumption of food may vary a small degree each year. It has been estimated that a person will consume the approximate following amounts annually.

310 lbs.	- fruits and vegetables - including potatoes
155 lbs.	- flour, cereal products - other grains
280 lbs.	- dairy products
525 lbs.	- meats and poultry products
110 lbs.	- oils and fats

Export Marketing of Principal Crops

Texas ranks first in exporting cotton and cottonseed oil; fourth in wheat, rice, and fruits; fifth in small grains for feed; and sixth in vegetables.

Crop products from the United States are found in many parts of the world. Ships sail daily from local ports with tons of food and feed to be placed in foreign markets. Major export crops over the past several years have been wheat, corn, rice, grain sorghum, tobacco, cotton, and oilseed crops (soybeans, peanuts, and cottonseed). Agriculture exports account for more than 16 percent of farm marketings by United States farmers. The export market absorbs over an acre of every five acres from which the crop is grown.

Crop exports vary according to world needs. For example, the total products and preparations exported in 1973-74 was slightly over 19 billion dollars. Three years later the amount exported totaled more than 21 billion dollars. The amount of crop products purchased by any one foreign country varies from year to year. This condition is controlled mainly by the quantity of the commodity produced in a particular country. Usually weather conditions is the major factor affecting production.

The leading markets of U. S. agricultural exports are listed in order (highest to lowest) according to the amount of dollars spent for U. S. commodities:

Japan
Netherlands
West Germany
Canada
USSR
Republic of Korea
United Kingdom
Italy
Taiwan
Mexico
Spain
Egypt
Belgium/Luxembourg
India

The Real Importance of Crop Plants

Animal life is dependent upon plant life. Without plant life the high protein foods (meats) would cease to exist. However, many parts of the world do not eat large amounts of meat; therefore, they use crop plants as their basic foods. It is estimated that seventy-five percent of the calories in the diets of people in underdeveloped parts of the world come from cereals, potatoes, sweetpotatoes, cassava, and other tropical crops. In the developed countries of the world only 35 percent of the calories in a diet are provided by starch foods. Other reasons why crop plants are important are:

Some plants not only provide food and feed, but they also provide fiber and other products.
They provide a more efficient use of land area and protect the soil.
They are used to beautify the landscape and surroundings.
They provide many types of occupations and specific jobs for the individual.

SUGGESTED STUDENT ACTIVITIES

1. Match the appropriate word with the following statements:

   a. Matching Words

      (1) Earth
      (2) 633
      (3) 117
      (4) Rice
      (5) 746
      (6) Corn
      (7) Africa
      (8) 7
      (9) Middle East
      (10) 110

   b. Statements

      (1) About __________ pounds of rice are consumed annually per person in the U. S.
      (2) Agriculture first began in the __________ __________ and spread to northern China.
      (3) Sorghum originated as a cultivated plant in __________.
      (4) There is about __________ million acres classed as forest land in the U. S.
      (5) The oldest crop found in the Western Hemisphere was __________.
      (6) The average annual per capita consumption of Irish potatoes in the U. S. is __________ pounds.
      (7) In 1685, __________ was grown successfully for the first time in the Carolinas.
      (8) Only 7.7 percent of the __________ is adaptable to cultivation.
      (9) The average annual consumption of wheat per person in the U. S. is about __________ pounds.
      (10) Land used for grazing purposes in the U. S. totals about __________ million acres.

2. Fill in the blanks with the word or words which will make true statements of the following:

   a. There have been over __________ species of plants used since crop plants were domesticated for food and fiber.
   b. Major root crops include __________, __________, and __________.
   c. Pulses are __________, __________, and __________.
   d. __________ leads all other grain crops as a basic food for all people.
   e. Most of the wheat is made into __________ for human use.
   f. Peanuts are used mainly as an __________ crop.
   g. The U. S. produces about __________ percent of the world's cotton.
   h. The individual's annual diet includes about __________ pounds of flour, cereal products, and other grains.
   i. Plants are very important to animal life in that they provide __________ and __________.
   j. About __________ percent of the corn crop is fed to livestock.

3. Discuss the following questions:

   a. List ten major crops grown in Texas and give their approximate value -

      (1)
      (2)
      (3)
      (4)
      (5)
      (6)
      (7)
      (8)
      (9)
      (10)

   b. List the percent of land area used for the following purposes:

      (1) Desert, swamp, dunes, rock __________%
      (2) Crop land __________%
      (3) Grass land __________%
      (4) Forest land __________%

   c. Discuss wheat as a food crop.

   d. Discuss the beginning of crop husbandry.

   e. List the major crop plant classes.

      (1)
      (2)
      (3)
      (4)
      (5)
      (6)
      (7)

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THE MAJOR AREAS OF CROP PRODUCTION–STATE, NATION, AND WORLD

There are many different kinds of factors that restrict certain crops to crop producing areas of the world. Four major factors include: climate, soil, available water, and economic conditions.

Climatic conditions consist of rainfall, length of growing season, temperature, wind velocity, humidity and sunlight, and day length. Crops differ in their capacity to grow and produce under various climatic conditions. Some examples are:

> Cotton, rice, sorghum, corn, cowpeas, and certain vegetables do better in warm climates.
>
> Wheat, potatoes, sugar beets, and many cereal crops (except corn) do better in cool climates.
>
> Flax, spring oats, wheat, and barley are adaptable to semiarid regions of the world. These crops are found in moderately dry areas in North America, Europe, and Asia.

Soils differ in type, thickness of soil layers, texture, color, and compactness. Some factors that cause soils to be different include: age, climate, parent material, slope of land, and vegetative cover. These factors cause the soil to have certain textures and structure. The size of the soil particle (gravel, sand, silt, and clay) determines the texture. The arrangement of particles (found in clumps or aggregates) refers to the term structure.

Soils in the United States have been grouped into families, types, classes, series, and even phases. The most widely used grouping is the land capability classification. Under this system of classifying soils, arable land is grouped both according to the possible productivity and limitations to productivity without special soil improvement practices being used. The first four classes can be used for cultivated lands and the last four classes for noncultivated lands. These classifications are:

> Class I soils are considered the best type of land for cultivation. They are slow to erode, almost level, deep, well drained, adequate water holding capacity, and a good nutrient supply. This class of land is used for crops, forest, range, pasture, and wildlife. Irrigation soils are in this group.
>
> Class II may have limitations such as a less than ideal depth, gentle slopes, moderate erosion, moderate salinity or alkalinity, slightly below ideal structure, may need some drainage practices. Class II soil can be used in the same way as Class I soil.
>
> Class III soils may restrict plant use. Slopes may be slightly to moderately steep, some wind or water erosion may be common, slightly permeable subsoil, subject to overflows, shallow top soil, poor fertility, and moderate alkalinity or salinity. These soils are used as Class I and Class II soils, but more good management practices are used to keep them productive.
>
> Class IV soils have more limitations than Class III soils. They may be very shallow, excessively wet, little water holding capacity, too alkaline, erode very easily and subject to overflows throughout the growing season. Even though these soils are used for crops, pastures, forest, and wildlife, they usually require carefully planned soil conservation practices. It is not the best practice to cultivate this class of soils extensively.
>
> Class V soils are nearly level; therefore, erosion is not considered a problem. They may be rocky soils and soils containing ponded areas. Some bottomlands are in this class because they overflow frequently. They are used only for pasture, forest, wildlife, and range.
>
> Class VI soils have many more limitations than Class V soils. They are considered to be very erodible or eroded, steep sloping, shallow, rocky, alkaline, salty, subject to frequent overflow, and lack water holding capacity. Only special crops may be grown on these types of soils such as orchard plants and certain berries. This type of land can be used only for pasture, forest, wildlife, and range.
>
> Class VII soils are much more restricted to land use than Class VI soils. They usually are stony, steep slope, erodible, alkaline, salty, and in some cases wet. Many of the soils in Classes V through VIII are lacking in plant nutrients. The restricted use includes grazing, forest, and wildlife.
>
> Class VIII soils are not considered for crops, grasses, or trees. Such limitations as erosion, water holding capacity, wetness, stoniness, salinity, or alkalinity usually cannot be corrected; therefore, the land is used for recreation, wildlife, or watersheds.

There are many economic factors that affect the type of crop grown in the different areas of any country in the world. Some of these factors are:

Land value
Labor requirements
Transportation
Demand for certain type of crops

Land that is valued high requires a high unit value crop. If there is a debt against the land, the unit value of the crop must be high enough to pay production cost, loan payment, interest on the loan, taxes, and to realize a profit.

Hand labor is still needed in certain crop areas. Most of the fruit and vegetable crops are still harvested and partly prepared for market by hand labor. Available labor is considered of great importance in crop production.

Transportation cost is a factor that may determine the type of crop enterprise. The method of transportation is not necessarily a limiting factor in crop production. Certain areas of the world population demand a specific type of food. For example, most parts of the world grow rice because people in those parts demand rice as their basic diet.

Available water supply for crop production, other than rainfall, comes from both underground and surface water. Underground water is not always available for all fertile land areas, so dams on rivers and smaller streams are constructed to catch and hold water for irrigation. There is approximately 37,000,000 acres under irrigation in the United States. In arid regions land is of little value for crop production unless adequate rainfall is available at the proper time.

Texas Crop Districts

Climatic conditions (amount and frequency of rainfall and frost free days) and soil types are the two major factors that affect the type of crops produced in the state. The location of the 14 crop reporting districts are listed in Figure 1. The major crops grown in each district are:

1N - Northern High Plains. Sorghum, wheat, hay, soybeans, cotton, barley, and vegetables.
1S - Southern High Plains. Cotton, corn, sorghum, hay, and vegetables.
2N - Northern Low Plains. Wheat, corn, barley, oats, hay, alfalfa, and guar.
2S - Southern Low Plains. Cotton, sorghum, wheat, oats, and hay.
3 - Cross Timbers. Oats, peanuts, hay, and wheat.
4 - Blacklands. Cotton, sorghum, wheat, barley, oats, corn, peanuts, vetch, and hay.
5N & 5S - East Texas. Corn, oats, peanuts, hay, soybeans, vetch, vegetables, and fruit.
6 - Trans-Pecos. Cotton, sorghum, barley, and hay.
7 - Edwards Plateau. Sorghum, oats, peanuts, and hay.
8N - South Central. Corn, sorghum, rice, cotton, flax, vegetables, and hay.
8S - Coastal Bend. Cotton, sorghum, flax, and hay.
9 - Upper Coast. Rice, sorghum, cotton, corn, vegetables, and hay.
10N - South Texas. Sorghum, peanuts, vegetables, flax, and citrus.
10S - Lower Valley. Cotton, sorghum, corn, hay, vegetables, and citrus.

Texas Crop Production by Leading Commodities and Counties 1976

Figures 2 - 11b give information concerning Texas leading crop commodities by counties.

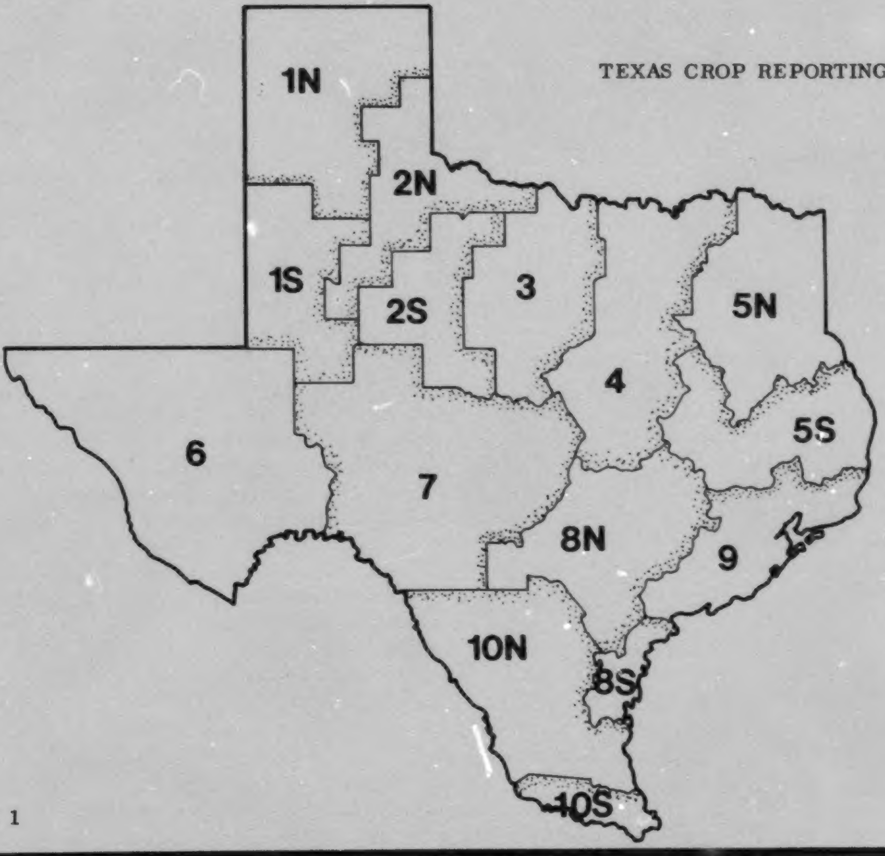


Figure No. 1

FIRST TWENTY LEADING COMMODITIES AND PERCENT OF RECEIPTS 1976

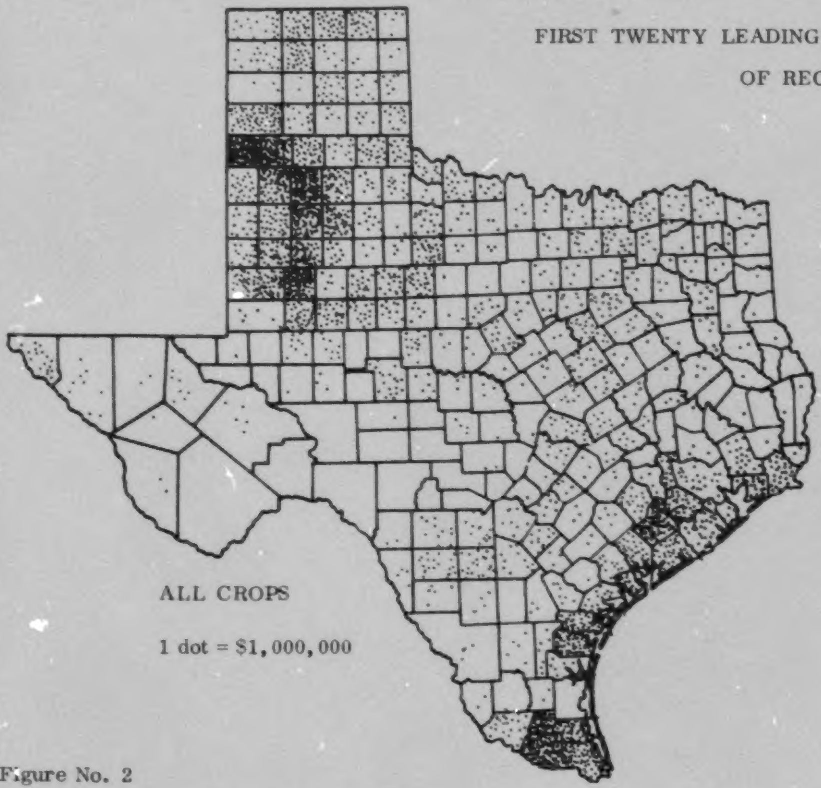


Figure No. 2

Crop Marketing in 1976

Commodity	Percent
Cotton Lint	14.8
Sorghum Grain	9.6
Corn	5.8
Wheat	4.6
Rice	3.5
Cottonseed	1.7
Peanuts	1.4
Hay	.9
Soybeans	.8
Onions	.7
Potatoes	.4
Watermelons	.3
Cabbage	.3
Carrots	.3
Cantaloupes	.3
Sugarcane	.2
Tomatoes	.2
Cucumbers	.2
Green Peppers	.2
Oats	.2

TEN LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

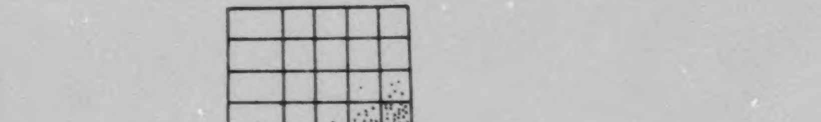
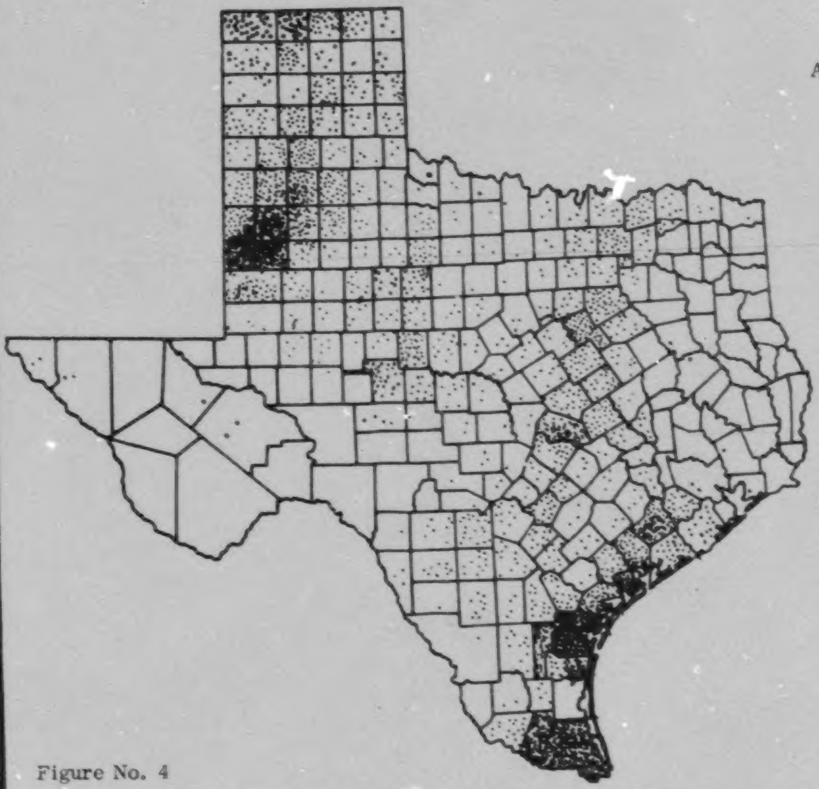


Figure No. 3

County	Bales	Percent
Dawson	244,200	7.38
Gaines	202,100	6.11
Lynn	200,100	6.07
Lubbock	195,300	5.91
Crosby	137,000	4.14
Martin	131,000	3.96
Hale	120,500	3.64
Terry	110,400	3.34
Cameron	106,200	3.21
Hockley	100,000	3.02



TEN LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

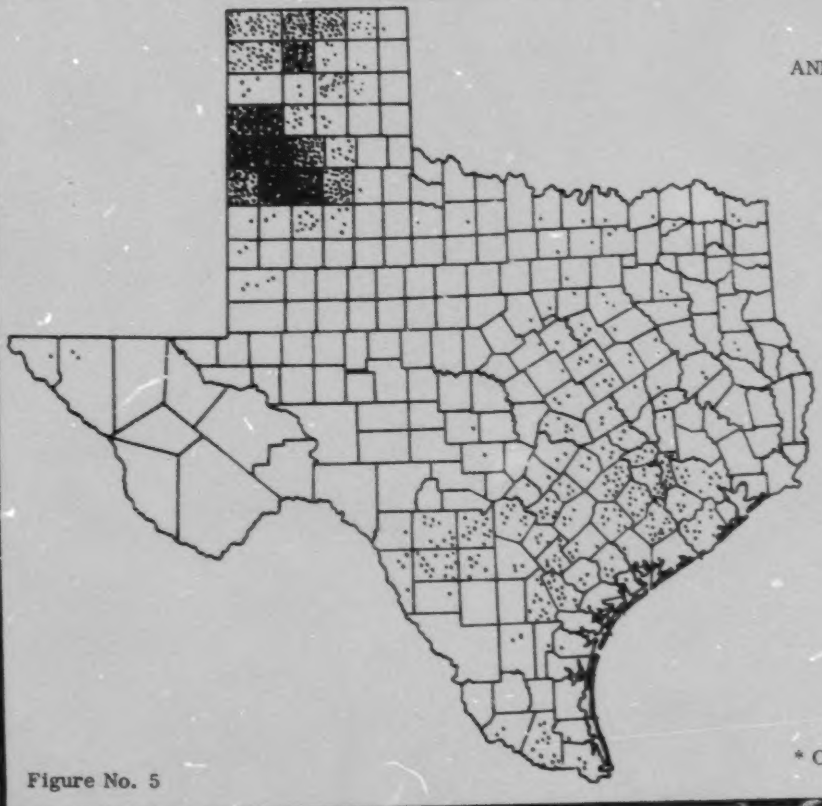
ALL SORGHUM

1 dot = 3,000 Acres

County	Bushels	Percent
Nueces	*14,816,800	5.1
Wharton	12,680,700	4.3
Hale	11,908,900	4.1
San Patricio	10,383,900	3.5
Swisher	9,587,100	3.3
Hidalgo	9,364,200	3.2
Floyd	8,226,000	2.8
Willacy	6,691,400	2.3
Cameron	6,517,100	2.2
Hill	6,495,900	2.2

* One bushel = 56 pounds except sorgo which is 50 pounds

Figure No. 4



TEN LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

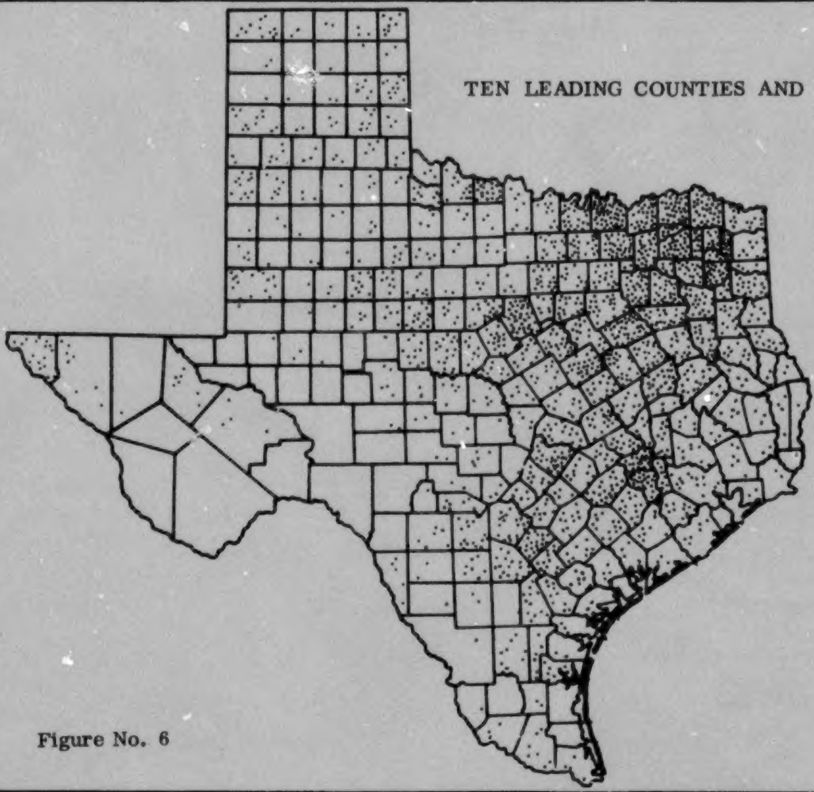
CORN

1 dot = 1,000 Acres

County	Bushels	Percent
Parmer	*40,165,700	22.3
Castro	24,017,000	13.3
Hale	16,662,400	9.3
Deaf Smith	15,991,100	8.9
Lamb	14,690,000	8.2
Swisher	6,784,000	3.8
Moore	6,763,700	3.8
Bailey	5,367,500	3.0
Sherman	5,274,300	2.9
Floyd	5,101,300	2.8

* One bushel ear (husked) corn weighs 70 pounds

Figure No. 5



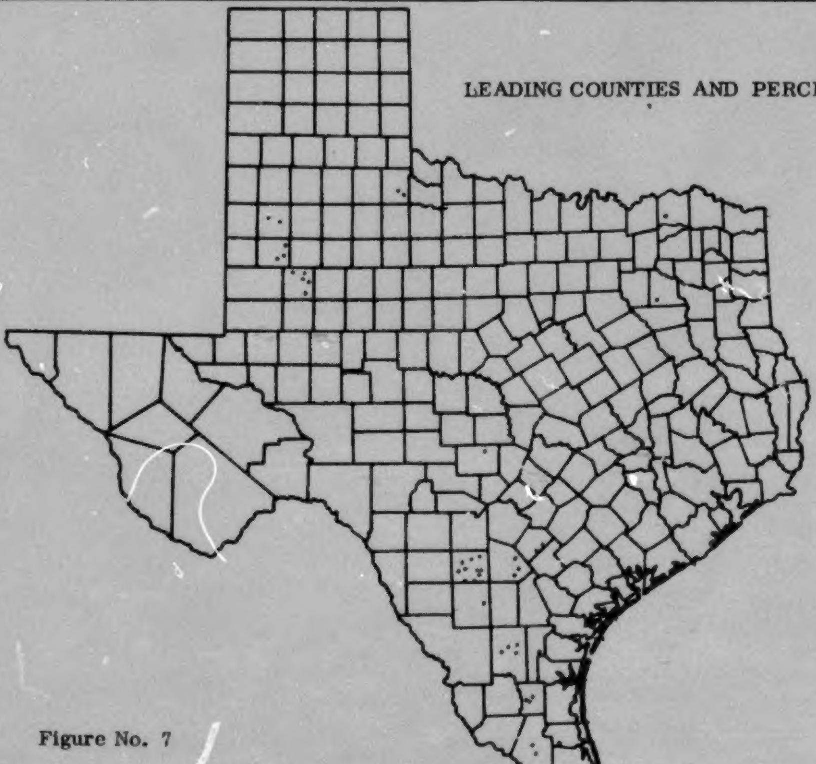
TEN LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

ALL HAYS

1 dot = 1,000 Acres

County	Tons	Percent
Grayson	135,400	2.5
El Paso	118,400	2.2
Lamar	113,200	2.1
Van Zandt	101,800	1.9
Hopkins	99,800	1.9
Red River	97,300	1.8
Travis	85,000	1.6
Gaines	77,800	1.4
Henderson	75,200	1.4
Bailey	74,800	1.4

Figure No. 6



LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

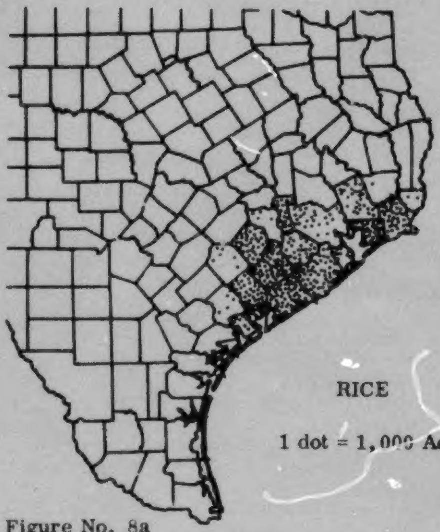
COWPEAS

1 dot = 500 Acres

County	Percent
Frio	35.3
Dawson	15.8
Duval	11.0
Atascosa	4.3
Willacy	3.8
Cottle	2.1
Wilson	2.0

Figure No. 7

LEADING COUNTIES
AND PERCENT OF STATE PRODUCTION



County	Percent
Wharton	17.0
Jefferson	10.4
Matagorda	10.3
Brazoria	10.3
Colorado	9.3
Chambers	8.4
Jackson	7.9
Liberty	6.4
Harris	5.4
Fort Bend	4.7

RICE

1 dot = 1,000 Acres

Figure No. 8a

PEANUTS

1 dot = 500 Acres

County	Percent
Comanche	16.2
Frio	11.0
Eastland	10.2
Atascosa	10.2
Wilson	6.3
Mason	4.0
Erath	4.0
Lee	2.2
Gaines	2.2
Fannin	2.1

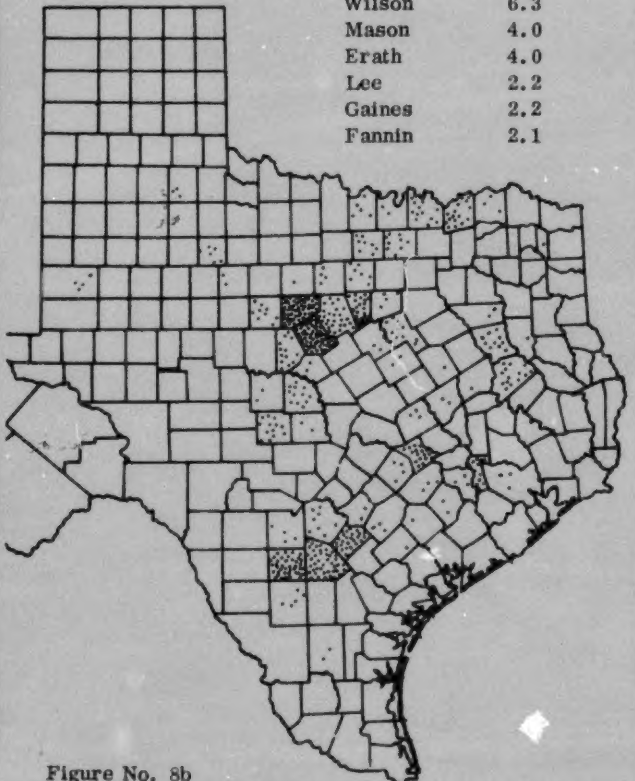
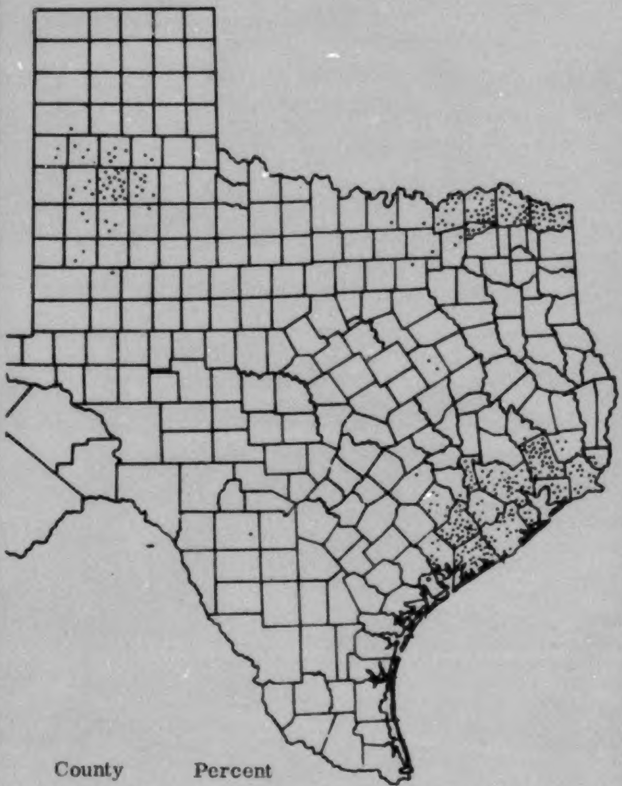


Figure No. 8b



County	Percent
Liberty	12.4
Wharton	11.6
Harris	9.8
Matagorda	8.3
Hale	6.9
Red River	5.0
Brazoria	4.4
Jefferson	4.2
Lamar	3.9
Waller	3.3

SOYBEANS

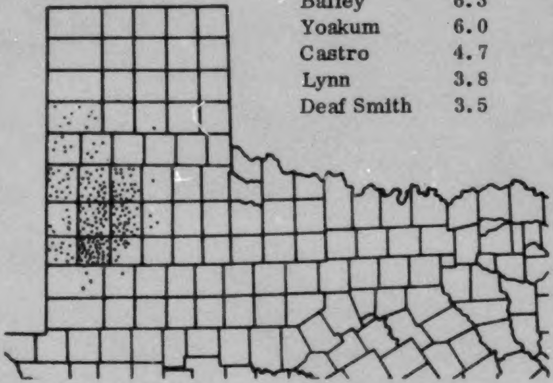
1 dot = 1,000 Acres

Figure No. 8c

SUNFLOWERS

1 dot = 500 Acres

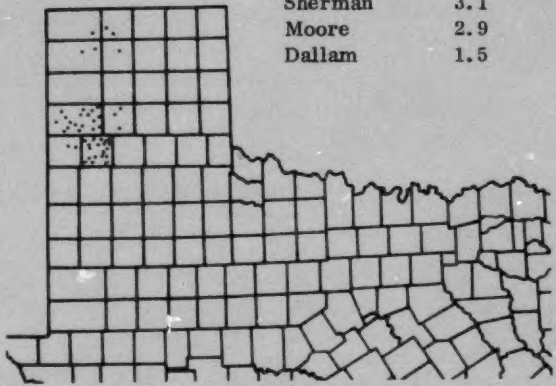
County	Percent
Terry	16.7
Hale	15.0
Lubbock	12.3
Lamb	11.2
Hockley	9.7
Bailey	6.3
Yoakum	6.0
Castro	4.7
Lynn	3.8
Deaf Smith	3.5



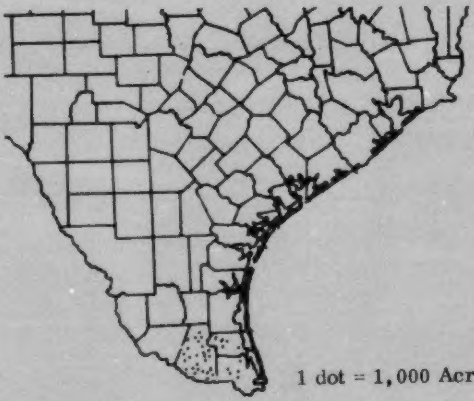
SUGARBEETS

1 dot = 500 Acres

County	Percent
Deaf Smith	39.5
Castro	38.0
Randall	6.1
Parmer	4.7
Hartley	4.0
Sherman	3.1
Moore	2.9
Dallam	1.5



LEADING COUNTIES AND PERCENT OF STATE PRODUCTION



1 dot = 1,000 Acres

SUGARCANE

County	Percent
Hidalgo	72.2
Cameron	14.5
Willacy	13.3

GUAR

1 dot = 500 Acres

County	Percent
Hardeman	13.3
Haskell	11.5
Knox	10.4
Wilbarger	10.0
Childress	6.7
Yoakum	6.6
Duval	4.7
Collingsworth	3.6
Stonewall	3.1

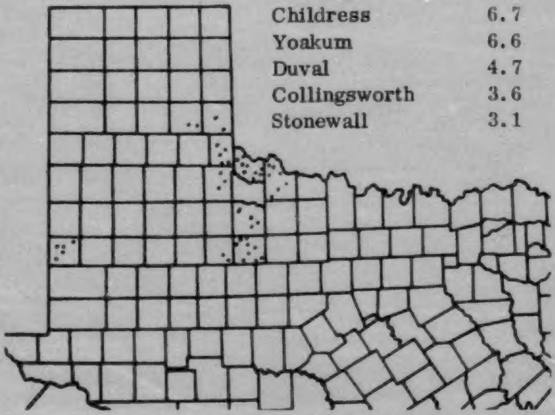
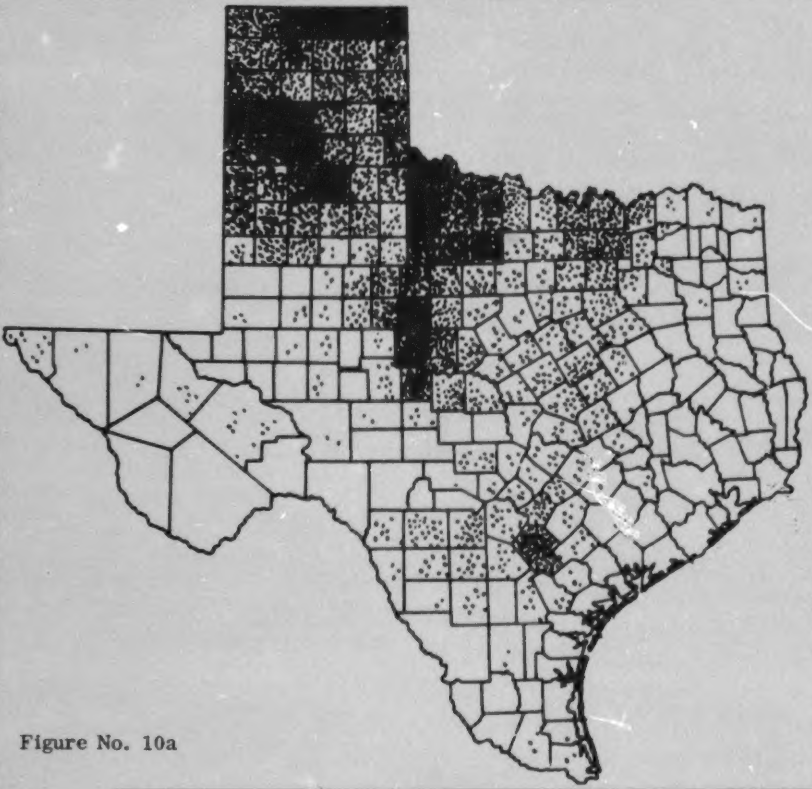


Figure No. 9



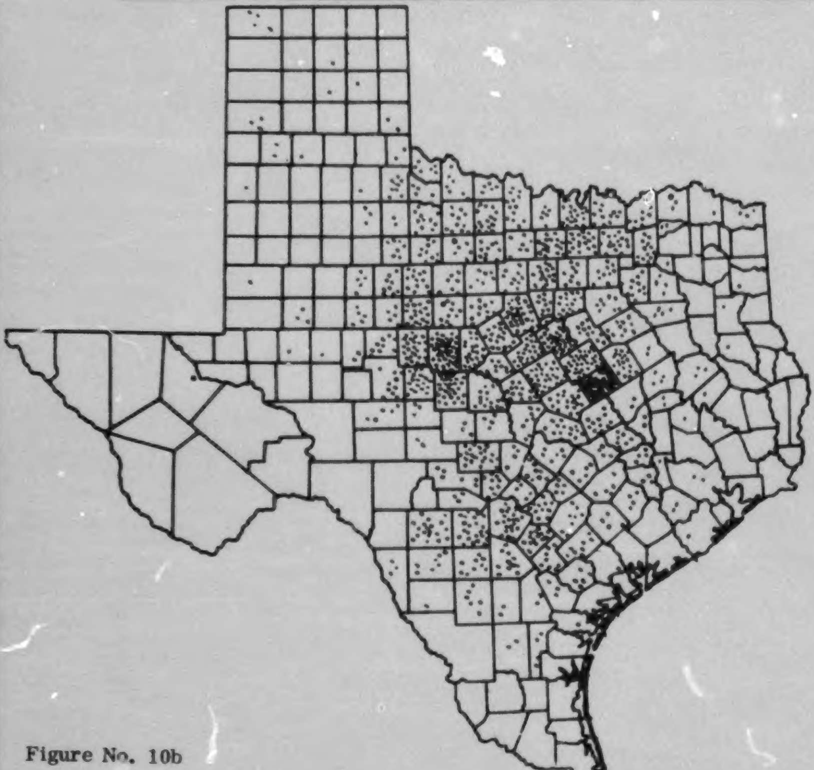
WHEAT

1 dot = 1,000 Acres

County	Acres Planted	Percent
Deaf Smith	354,000	5.45
Ochiltree	310,000	4.77
Hansford	227,000	3.49
Sherman	195,000	3.00
Randall	177,000	2.72
Dallam	166,000	2.55
Carson	163,000	2.51
Hardeman	157,000	2.42
Lipscomb	149,000	2.29
Floyd	137,000	2.11
Total for State	6,500,000	

Figure No. 10a

LEADING COUNTIES AND PERCENT OF STATE PRODUCTION



OATS

1 dot = 1,000 Acres

County	Acres Planted	Percent
Falls	78,000	5.57
Coleman	46,000	3.30
McLennan	44,000	3.14
Bosque	36,000	2.57
McCulloch	32,000	2.30
Erath	30,000	2.14
Hamilton	29,000	2.07
Coryell	27,000	1.93
Runnels	27,000	1.93
Brown	22,000	1.57
Total for State	1,400,000	

Figure No. 10b

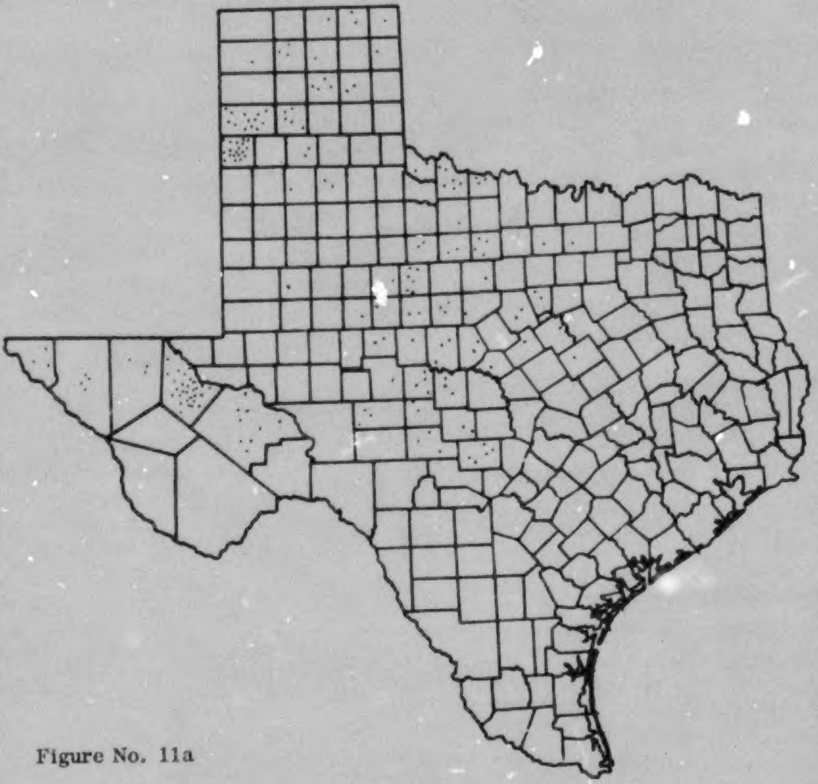


Figure No. 11a

LEADING COUNTIES AND PERCENT

OF STATE PRODUCTION

BARLEY

1 dot = 500 Acres

County	Acres Planted	Percent of Planted Acres
Reeves	10,500	9.55
Parmer	8,700	7.91
Deaf Smith	6,000	5.45
Pecos	3,100	2.82
Jones	3,100	2.82
Concho	2,000	1.82
Gillespie	1,900	1.73
Randall	1,900	1.73
Carson	1,800	1.64
Schleicher	1,700	1.55
Total for State	110,000	

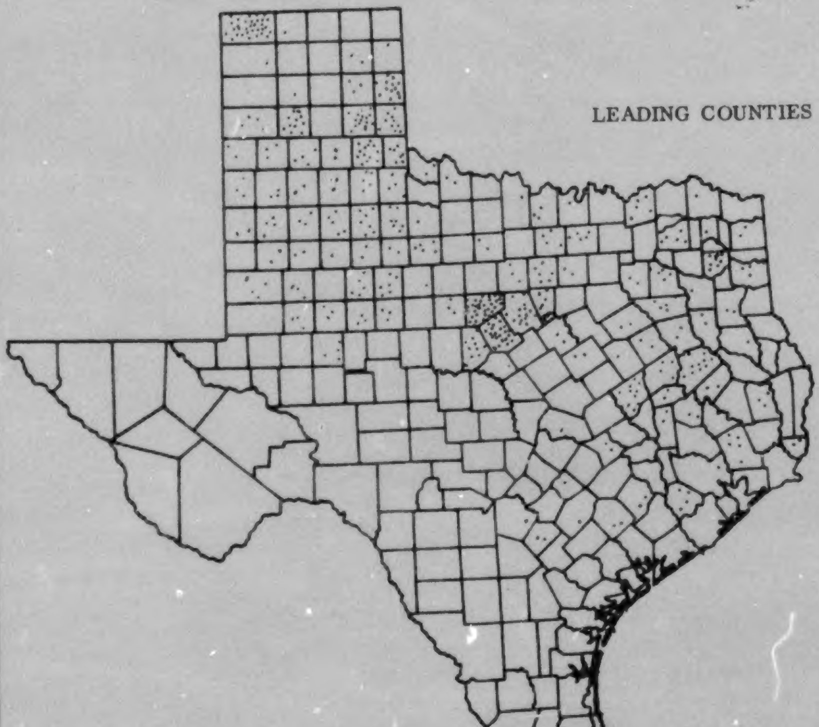


Figure No. 11b

LEADING COUNTIES AND PERCENT OF STATE PRODUCTION

RYE

1 dot = 500 Acres

County	Acres Planted	Percent of Planted Acres
Dallam	15,900	6.36
Eastland	15,800	6.32
Comanche	11,000	4.40
Donley	8,000	3.20
Erath	7,700	3.08
Wheeler	6,600	2.64
Hall	6,500	2.60
Randall	6,200	2.48
Collingsworth	5,200	2.08
Houston	4,900	1.96
Total for State	250,000	

Major Crop Areas in the United States

There is about 480 million acres available for use as cropland. This amount includes some improved pasture land. About 75 percent of the 480 million acres can be classed as cultivated land used for crops. There are 11 major crop areas in the United States in Figure No. 12. Similar areas may be separated by several states. Such areas grow the same or similar crops. These areas and crops are as follows:

Pacific Subtropical Region - This region is located in the southern two-thirds of California but less than one-half of that part of the state. Rainfall varies from 10 to 20 inches; therefore, fruits, vegetables, Irish potatoes, and cotton are produced by using irrigation practices.

North Pacific Hay and Pasture Region - This region extends from Central California along the coast to Canada. Annual rainfall may range from 100 inches on the north coast to 40 inches at the south end. Barley, wheat, oats, rye, rice, flax, and hay are the principal crops.

Columbia Wheat Region - This area is located in northern Oregon, parts of Idaho, and southeastern Washington. It is a plateau region that receives 15 to 20 inches of rainfall annually. Wheat is the major crop in this area. However, barley, alfalfa, rye, and Irish potatoes are also important crops in this region.

Grazing and Irrigated Crop Region - This region covers several states. It includes far west Texas, most of New Mexico, Colorado, Wyoming, Idaho, Oregon, Nevada, Utah, and Arizona. The mountain ranges are mostly covered with forests, and the plains are either covered with grass, sagebrush, or other desert vegetation. The irrigated parts produce wheat, sorghum, Irish potatoes, hay, sugarbeets, cotton, vegetables, and fruits.

Western Forest and Hay Region - This area is located in parts of three states; Washington, Montana, and Idaho. The most important crops are hay, wheat, barley, sugarbeets, Irish potatoes, and vegetables.

Eastern Forest and Hay Regions - These two regions are located in Maine and New York. The major crops are hay, Irish potatoes, and some small winter grains.

Spring Wheat Region - This area includes most of North and South Dakota, part of Montana, and the Red River Valley of Minnesota. This is a spring wheat area, but other crops such as hay (clover, timothy, and alfalfa), soybeans, rye, flax, sugarbeets, and Irish potatoes are grown.

Hard Winter Wheat Region - This type of wheat is produced in the Panhandle of Texas, northwestern Oklahoma, and western two-thirds of Kansas. The area also extends into parts of Oklahoma, New Mexico, Colorado, and Nebraska. Sorghum, alfalfa, barley, and oats are considered important crops in this region.

Cotton Belt - This area includes most of Texas, Oklahoma, Arkansas, and the other southern states except Florida. Rainfall may range from 60 to 25 inches. Cotton, corn, sorghum, peanuts, tobacco, rice, sugarcane, soybeans, cowpeas, hay, vegetables, and fruits are major crops.

Corn and Winter Wheat Belt - This belt begins parts of Oklahoma and Kansas and extends into parts of Pennsylvania. It takes in parts of Missouri, Arkansas, Tennessee, Kentucky, Ohio, Indiana, Illinois, Maryland, and Virginia. Rainfall is usually above 40 inches annually. Corn, winter wheat, hay, soybeans, and vegetables are major crops in this region.

Corn Belt - The corn belt is located in an area from eastern Ohio, westward to Kansas and South Dakota. It takes in the entire state of Iowa, most of Illinois and Indiana, northern parts of Kansas and Missouri, half of Nebraska, and the southern parts of Minnesota and Wisconsin. Corn, wheat, oats, hay, soybeans, and barley are the most important crops in this belt.

Hay and Dairy Region - This region joins the Spring Wheat Region on the west, the Corn Belt on the south, and along the Canadian border from Minnesota to Maine, Wisconsin, New York, and Minnesota are in this area. Parts of Ohio, West Virginia, and Pennsylvania are also included. Rainfall is usually between 25 and 50 inches. Crops in this region include hay, corn, wheat, oats, barley, and Irish potatoes.

Humid Subtropical Corn Belt - This region is a narrow strip of land including the entire state of Florida to the lower southern part of Texas. The rainfall varies from about 40 to 60 inches along this area. Rice, corn, sorghum, hay, fruits, vegetables, and sugarcane are the major crops.

Middle Altantic Truck Crop Region - This area is a narrow region extending from north Florida up the Altantic coast to the New England states. The area produces such crops as vegetables, fruits, hay, and soybeans.

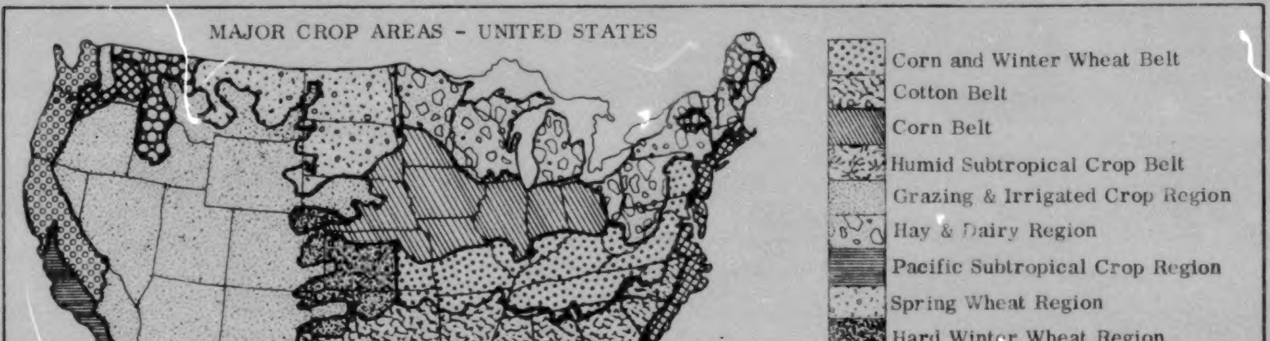

MAJOR CROP AREAS - UNITED STATES
Corn and Winter Wheat Belt
Cotton Belt
Corn Belt
Humid Subtropical Crop Belt
Grazing & Irrigated Crop Region
Hay & Dairy Region
Pacific Subtropical Crop Region
Spring Wheat Region
Hard Winter Wheat Region
North Pacific Hay & Pasture Region
Forest & Hay Region
Middle Atlantic Truck Crop Region
Columbia Wheat Region

Figure No. 12

Major Crop Producing Areas of the World and Crops Produced

Figure No. 13 shows that the United States and Canada, South America, Europe, North Africa, South Africa, India, China, Australia, and Russia all produce vast amounts of crop products for food and feed. The type of crop grown in the different countries is determined or restricted to the amount of annual rainfall, temperature, growing season, and soil type. These crop producing areas are:

United States and Canada - The U. S. and Canada possess 22.7 percent of the world's cultivated land. These two countries rank first in wheat, corn, oats, hay, and tobacco production. The United States leads in cotton, corn, wheat, vegetable, and fruit production.

South America (Argentina and Brazil) - These two countries produce rice, coffee, sugarcane, cocoa, cotton, beans, potatoes, and barley. Other important crops produced in this area are wheat, oats, rye, corn, flax, and alfalfa.

Europe (Western and Central) - Europe produces hay crops, wheat, oats, barley, rye, sugarbeets, corn, and flax.

North Africa - North Africa produces cereal crops in the irrigated regions. Cotton and oil producing plants are considered important in Egypt, Algeria, and Morocco.

South Africa - South Africa produces mostly cereals. The principal cereal crops are: grain sorghums, corn, wheat, oats, barley, and rye. Other major crops grown in the country are cotton, sugarcane, and hay.

India - Rice is considered a very important crop. Grain sorghum, millet, wheat, barley, and pulse crops are also important food plants. Sugarcane, flax, and jute are grown in certain areas of the country.

China - China, like India, produces rice and other cereal crops for its large population. Sugarcane is considered a very important crop in certain areas.

Australia - Even though Australia is about the size of the U. S., its cultivated land is only about one-fifteenth of that of the U. S. due to most of the country receiving insufficient rainfall for crop production. Much of the country is used for grazing livestock.

Russia - The Asiatic area of Russia is about three times of that in the U. S. The total land area is about five and one-half billion acres. Over 10 percent is in cultivation. The chief crops in the central region are flax, wheat, rye, oats, and barley. Southwest Russia produces wheat, barley, oats, rye, flax, and potatoes. Hay is grown in the northern part.

MAJOR CROP AREAS - WORLD

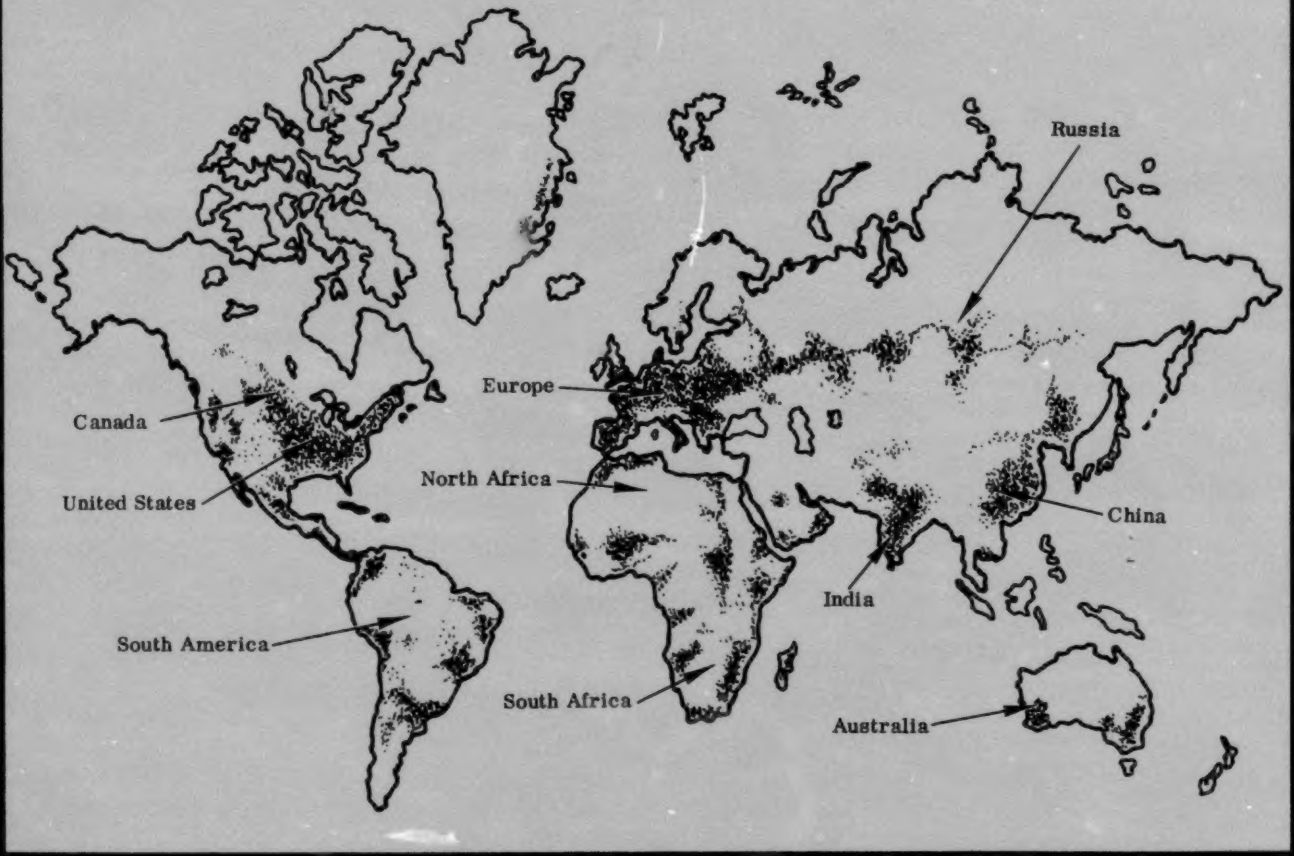


Figure No. 13

SUGGESTED STUDENT ACTIVITIES

1. Briefly discuss the following statements:

   a. Four major factors that restrict crop producing areas

      1. Climate -

      2. Soil -

      3. Water Supply -

      4. Economic Conditions -

   b. Describe the Cotton Belt region.

2. Completion

   a. Class __________ soils are considered the best type o soil for cultivation.
   b. Texas is divided into __________ crop reporting districts.
   c. __________ has been the leading crop in Texas for several years.
   d. There is about __________ million acres of arable land in the United States.
   e. The four major crop areas in Texas are:
      (1)
      (2)
      (3)
      (4)
   f. The U. S. and Canada possess __________ percent of the world's cultivated land area.
   g. One of the main crops produced in India is __________.
   h. Cotton, rice, sorghums, corn, and cowpeas do better in areas where the climate is __________.
   i. Class __________ soils are used for recreation instead of crops.
   j. Most parts of the world grow __________ because it has become a basic food in the diet.

3. Identify the location of the following crops grown in Texas by listing the proper crop reporting district or districts:

   a. Cotton
   b. Grain sorghum
   c. Corn
   d. Rice
   e. Soybeans
   f. Sunflowers
   g. Sugarcane
   h. Sugarbeets
   i. Wheat
   j. Guar

NOTES

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PLANT STRUCTURE-FUNCTIONS OF PLANT PARTS

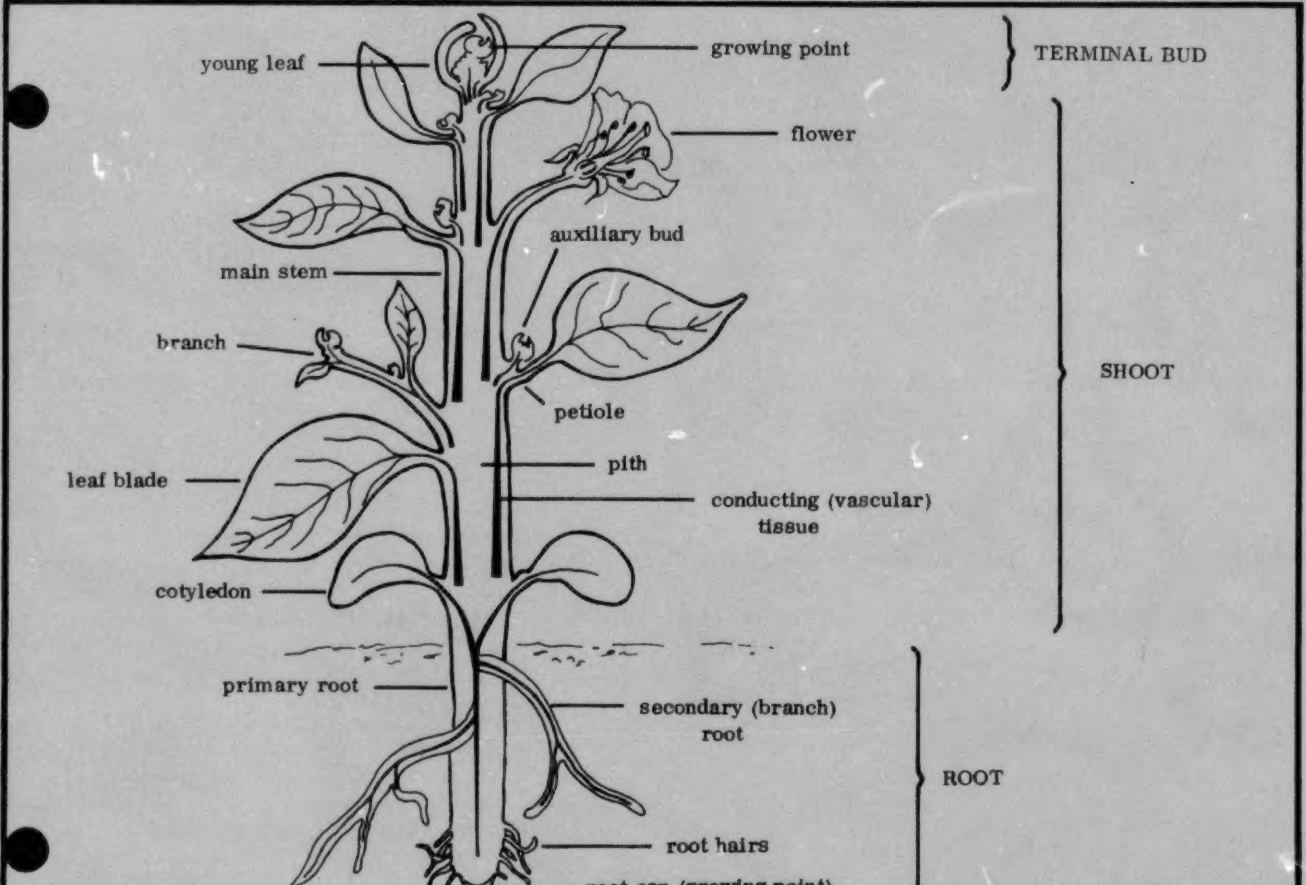
Plant and animal structures are similar in that the structural unit is the cell. Most plants are multicellular, and plant growth is the result of the many cells dividing or enlarging. In order for the cells to multiply or enlarge and the plant to grow the plant must have plant nutrients in the form of the following raw materials: carbon dioxide, water, oxygen, nitrogen, phosphorus, and many trace elements. Other comparisons of plant and animal growth are:

> Plants make their own food, whereas animals cannot. There is one group of cells in plants that perform this task. Other cells conduct plant materials, support plant parts, serve to store food, and absorb plant nutrients. Still other types serve to support the plant.
>
> Plant cells vary in shape, size, and even in the nature of material that forms cell walls. Yet, their chemical composition and chemical changes are similar to animal cells.

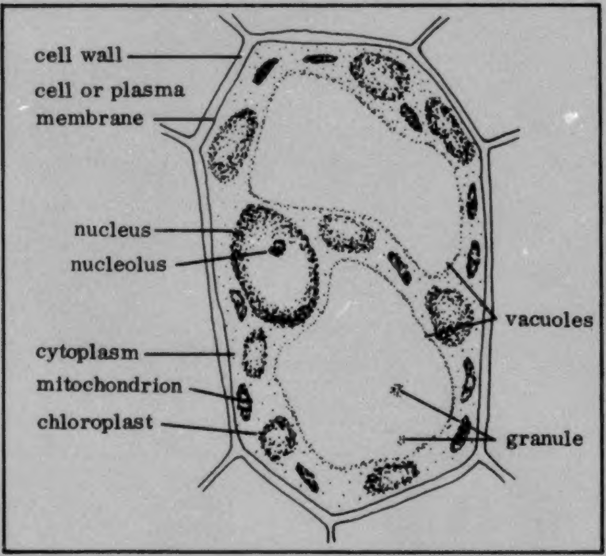
Both plants and animals breathe. The organism supplies its cells with oxygen needed for metabolism and relieves them from carbon dioxide formed in the energy - producing reactions.

Plants and animals use protein, fats, and carbohydrates for energy and growth, but plants differ from animals in their ability to use carbon dioxide in manufacturing food. Plants can also build up valuable organic substances from simple materials.

The main parts of a plant are similar to the main organs of the animal, in that the lung, heart, and digestive organs perform functions for the animal body as roots, leaves, stems, and flowers of the plant perform similar functions for the total plant. These fundamental parts are listed on the following diagram:


young leaf
growing point
TERMINAL BUD
flower
auxiliary bud
main stem
branch
SHOOT
petiole
pith
leaf blade
conducting (vascular) tissue
cotyledon
primary root
secondary (branch) root
ROOT
root hairs
root cap (growing point)

The important plant structures such as the leaves, stems, roots, and buds are made up of plant cells. These cells are very small in size (1/100 to 2/100 millimeter in diameter) and are found in various shapes. They may be round, oblong, tubular, blocky, and have many sides. The plant cell consists of a mass of protoplasm and nucleus confined within a cell wall. Protoplasm is the living matter of a cell. It consists of a liquid chemical mixture of water, starches, sugars, fats, proteins, and mineral salts. The cell is actually where the plant life takes place. The parts are shown on the following diagram and listed below:



Cell Wall................	Non-continuous membrane that surrounds plasma membrane.
Plasma Membrane.......	Surrounds cytoplasm (protoplasm) within the cell wall.
Chloroplast.............	Specialized colored bodies (chlorophyll) in cytoplasm.
Vacuole.................	Cavities in cytoplasm filled with cell water.
Nucleus.................	A small round body within a cell nucleus.
Nucleolus...............	Body of specialized protoplasm containing chromosomes within a cell.
Granule.................	A small particle within the vacuole.
Cytoplasm...............	Total protoplasm in the cell except the cell nucleus.
Mitochondrion...........	Cytoplasmic bodies within the cell where compounds and sugars are broken down and pass to other compounds that carry energy. Mitochondria are thought of as "power plants" of the cell.

Plant Tissues and Tissue Systems

There is a group of cells in the plant that vary in size and structure. The variation between plants is caused by cell arrangement and cell form. Organized masses of these similar type cells that help make up the plant are called tissues. Even though the plant originates from one cell (fertilized egg), cell division and change produce an organism that is comp[illegible]d of cells that are different structurally and in the way cell[illegible]e made up. Plant tissues are classified according to origin, structure, and physiology. The classifications are as follows:

1. Meristematic Tissue - This is a growth tissue; therefore, it is found near the tips of roots and stem buds. Vascular cambium tissue increases growth in diameter of both stems and roots. Cork cambium tissue is located in the outer bark of trees and shrubs.

2. Permanent Tissue - This type of tissue is divided into two parts according to cell structure, simple tissue which consists mainly of one type of cell, and complex tissue which consists of several types of cells.

   a. Simple Tissues

      (1) Epidermal tissue - This type of tissue is usually one cell thick and forms the outer layer of flowers and leaves, plus many types of fruits. The two main functions of this tissue are to keep moisture in the inner tissue and protect the plant against insects.

      (2) Parenchyma tissue - It makes up the fleshy part of fruits, roots, and tubers; therefore, it is the most common and most abundant of plant tissue. Its main function is to store food and water. W[illegible]e the parenchyma cells contain chloroplast th[illegible]sue functions in food synthesis.

      (3) Collenchyma tissue - This type of cell group has thick cell walls composed mainly of cellulose in most plants. It serves to strengthen the stems and leaves.

      (4) Sclerenchyma tissue - This type of tissue is made up of cells with thick cell walls. The fibers and sclereids composed of tissue cells give strength and support to plant organs.

   b. Complex Tissue

      (1) Xylem tissue - This type of tissue is usually called wood in vascular plants. Its principal functions are to conduct water and support the plant. Xylem is also found in herbaceous plants. Woody plant conduction is carried on by vessels (vertical tubes) and tracheids (elongated tapering cells which are dry when mature).

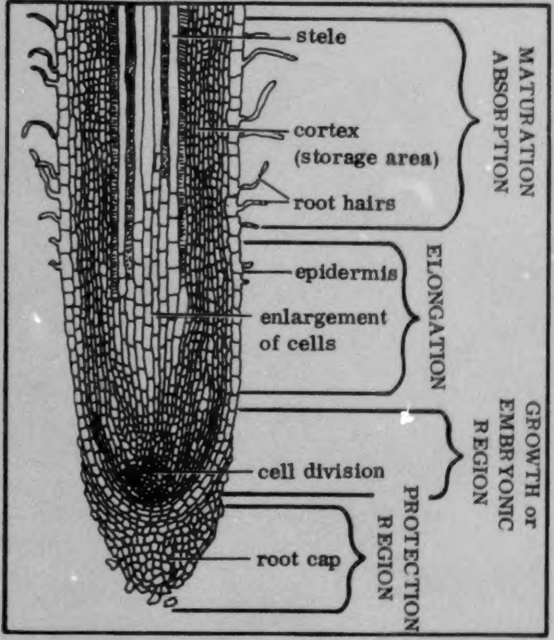
      (2) Phloem tissue - This type of tissue also conducts material in the plant and gives the plant support. The tissue's main function is to conduct foods that have been manufactured in the leaves to the plant roots. Sieve tubes are the basic componen[illegible]f the phloem. Such fibers as hemp and fla[illegible]e phloem tissue.

Major Component Parts of Plants

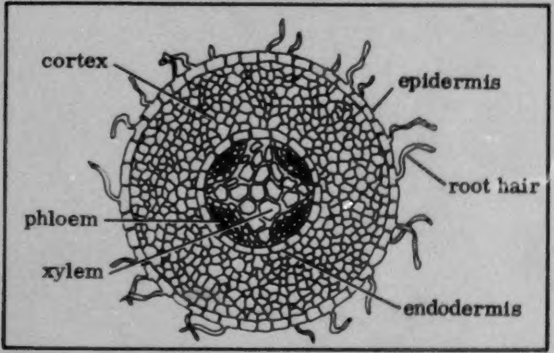
1. The Root System

Usually plant roots are the part of the plant that cannot be seen. Yet, they may consist of half the weight of the entire plant. Their major functions are to absorb water and minerals from the soil, store food reserves in some crops, and anchor most crops in the soil. Non-soil roots are: aerial (ivy), aquatic (water lily), and cypress knees (projections from cypress tree roots). Soil roots are classified in two main types: tap (cotton, carrots, etc.) and fibrous (grasses and cereal plants). A tap root is formed when the primary root becomes the main root, and a fibrous root system is formed when the primary root ceases to grow and the plant is supported by new roots growing out of the stem.

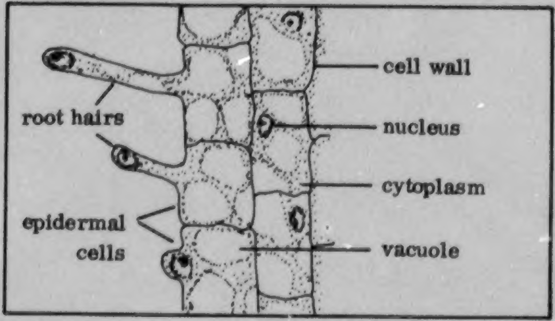
a. Tissue Development and Root Tip Growth


stele
cortex (storage area)
root hairs
MATURATION ABSORPTION
epidermis
enlargement of cells
ELONGATION
GROWTH or EMBRYONIC REGION
cell division
root cap
PROTECTION REGION

(1) This longitudinal section of a young root shows the maturation and absorption region, the growth region, tissue development, and protection region.


cortex
epidermis
root hair
phloem
xylem
endodermis

(2) The cross section of a young root shows the types of cells and plant root tissue. This diagram shows the location of the endodermis which is not shown in the longitudinal diagram.


cell wall
root hairs
nucleus
cytoplasm
epidermal cells
vacuole

(3) Root hairs are found just above the elongation section on a young root. These root parts develop as an out growth of the epidermal cells. Most plants produce root hairs that live only a few days or a few weeks. As the plant continues to grow new root hairs are formed on the new growth.

b. Root Cells and Tissue and Their Function

(1) Epidermis	Absorption, protection
(2) Stele	Contains the vascular system (xylem and phloem). Moves water and minerals to the top of the plant and food from the leaves to the roots.
(3) Cortex	The cortex is a tissue located between the epidermis and stele. Here the plant stores food and water.
(4) Endodermis	Single layer of cells that encases the stele.
(5) Phloem	This tissue is found both in the root and stem of plants. It has the same function in both plant parts, food conduction.
(6) Xylem	This is another vascular tissue that serves the plant as a conductor of foods (water and minerals).

c. Factors That Influence Root Growth

(1) Roots grow better in a soil with an adequate supply of moisture, but not water-soaked.

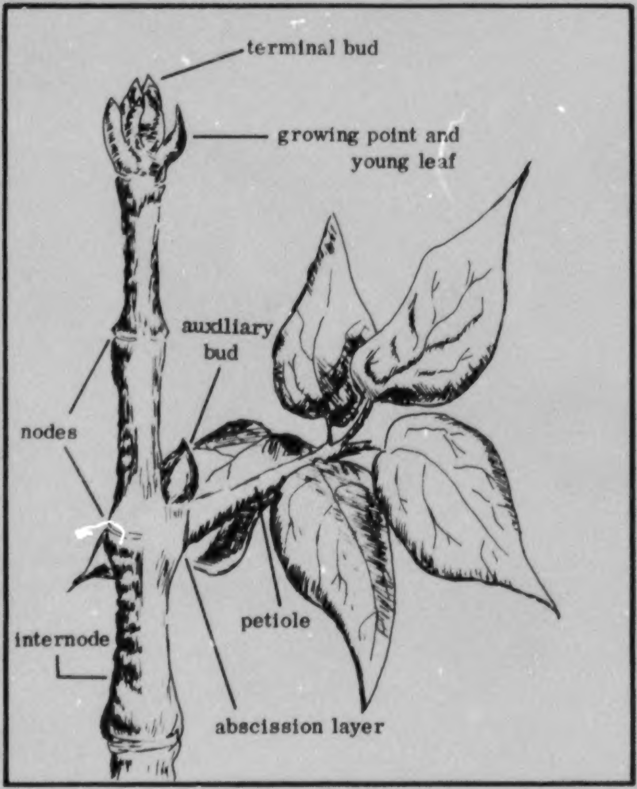
(2) Soil fertility and acidity determine the rate of growth of the plant root system. Adequately fertilized plants produce food in the leaves, which supplies energy for the roots to develop in the soil.

(3) Soil aeration and structure are considered very important to root growth. The lack of oxygen retards growth and prevents the production of root hairs. Hardpans and compacted soils tend to limit root growth.

2. The Plant Stem

The stem is one part of the shoot system. The other parts include the branches and leaves on aerial or above ground plants. Most flowering plants have aerial stems. Herbaceous or nonwoody plants have stems that contain some chlorophyll. A small amount of photosynthesis takes place in this type of stem. The stem's major functions are to join the root and leaf systems together and transport materials between these two systems. Stems also serve as supports for the reproductive or flower parts of a plant. Food and feed come from such items as asparagus, sugar cane, corn, and many grass plants.

a. Stems and Other Parts and Their Functions


terminal bud
growing point and young leaf
auxiliary bud
nodes
petiole
internode
abscission layer

(1) Nodes - A leaf or bud develops on this jointed part of the stem where it remains attached until it separates from the plant.

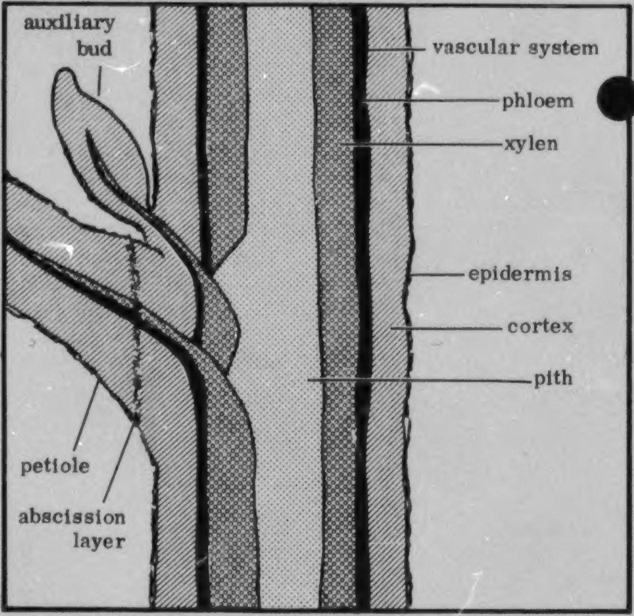
(2) Internodes - Parts on the stem between the nodes.

(3) Auxiliary Buds - These buds are found at the leaf axils. Flowers and branches are often found arising from auxiliary buds.

(4) Terminal Bud - The tip or end of the shoot where the growth takes place is known as the terminal bud.

(5) Abscission Layer - This part is a thin cell layer where the branches and leaves separate from the plant or stem. Leaf separation usually takes place at the base of the petiole or leaf stalk.

b. Function of Stem Parts


auxiliary bud
vascular system
phloem
xylen
epidermis
cortex
pith
petiole
abscission layer

(1) Vascular System - Contains the xylem and phloem which are veins that conduct water and nutrients.

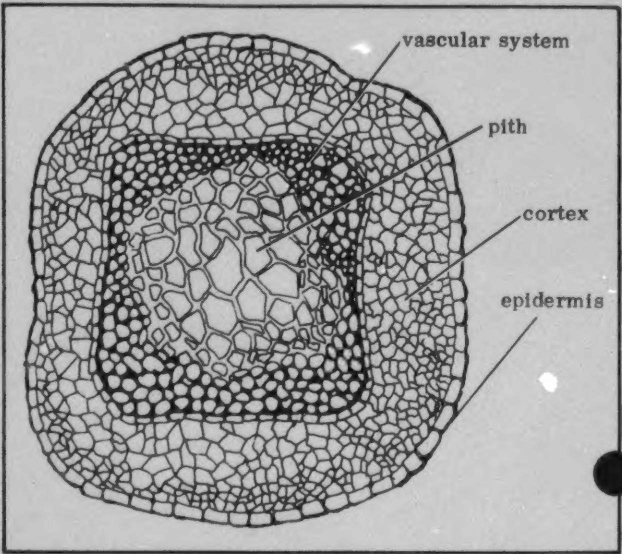
(2) Cortex - Stores food and water and conducts plant foods.

(3) Pith - Pith cells are for food storage in many plants.

(4) Epidermis - As in other plant parts it serves as the outermost layer.

(5) Xylem - Conveys water and minerals and supports the plant. Functions the same as in the root.

(6) Phloem - Conducts plant food materials through sieve tubes. Functions the same as in the root.


vascular system
pith
cortex
epidermis

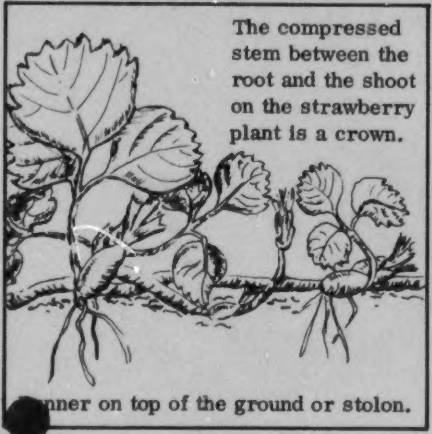
c. Types of Above Ground and Below Ground Stems

(1) Above Ground Forms

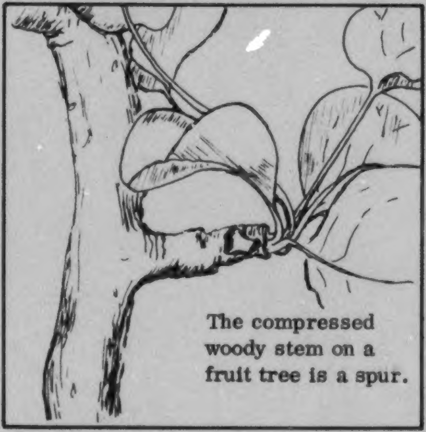
- (a) Crowns - Stems just below the ground surface and in some cases above the ground. The part between the root and shoot.
- (b) Stolons - Runners or stems that grow horizontally on the ground. They have long internodes.
- (c) Spurs - Stems of woody plants where growth is restricted. They have short internodes.

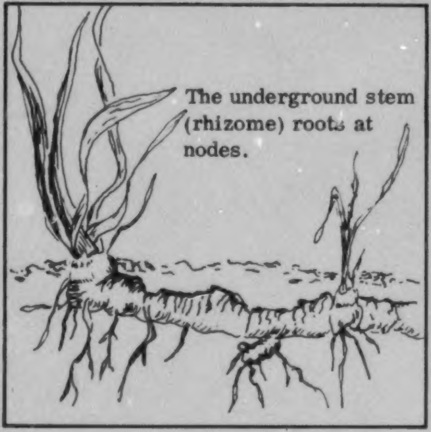
(2) Below Ground Forms

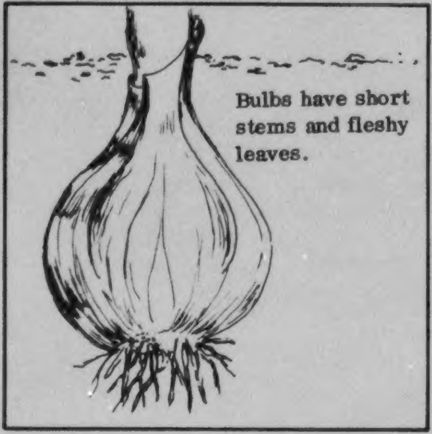
- (a) Rhizome - Underground stems that grow horizontally. Some are compressed and fleshy, whereas others are with long internodes (many grasses).
- (b) Bulbs - Bulbs are below ground stems that are short, disk-shaped, or flattened. The scales of a bulb are leaf-like layers as in the onion and they enclose the shoot or buds.
- (c) Corms - These are underground stems, and like the bulb, they are found only in certain monocotyledonous plants. A corm is fleshy and short with a few nodes. The gladiolus is an example of a plant being grown from a corm.
- (d) Tubers - Tubers are also fleshy parts of underground stems. This is the part of the potato that is edible. The eyes on the potato are buds.

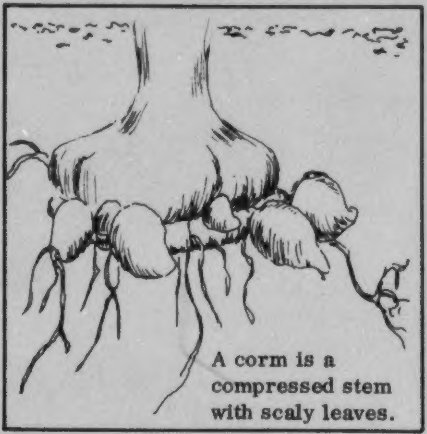

The compressed stem between the root and the shoot on the strawberry plant is a crown.

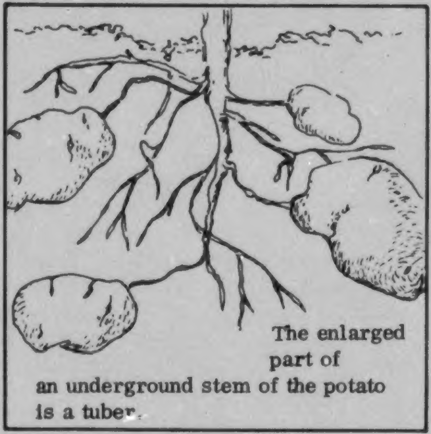
Runner on top of the ground or stolon.


The compressed woody stem on a fruit tree is a spur.


The underground stem (rhizome) roots at nodes.


Bulbs have short stems and fleshy leaves.


A corm is a compressed stem with scaly leaves.


The enlarged part of an underground stem of the potato is a tuber.

3. The Plant Leaf

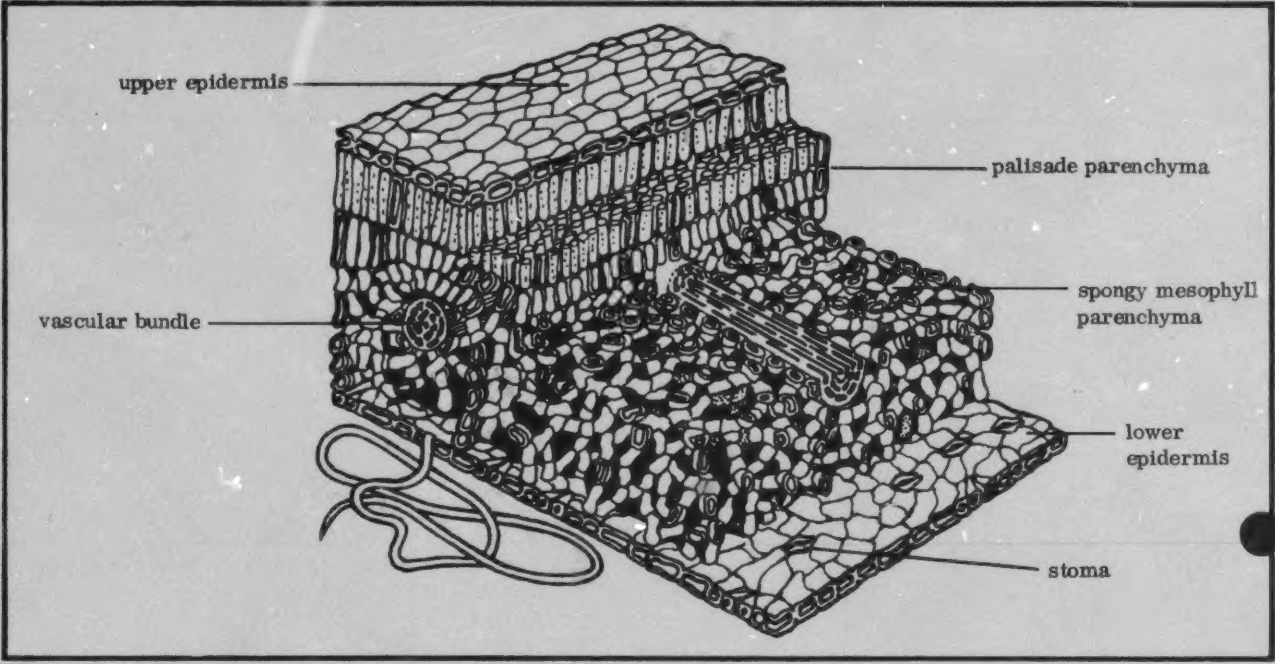
The leaf is that part of the plant where the food is manufactured through the process of photosynthesis. This process is thoroughly explained in the Student Material IV-B-3, How Plants Make, Use, and Store Food. Other functions of the leaf include transpiration (evaporation of water) and serving as a food storage area for some plants.

Most plants have flat leaves with large areas arranged in such a way as to take in light energy to manufacture food. However, thin blades or needle-like leaves as found on the conifers and stem-like fleshy leaves on cactus also have total leaf areas adequate for producing abundant plant food. Dicot plant leaf blades are attached to the stem by the petiole (thin stem). They also have one blade per petiole which makes a simple leaf. If the plant has more than one leaf per petiole, the leaf structure is compound. Many plants have leaf-like growths at the base of the petiole.

Leaves of deciduous plants separate from the stem and fall from the branches. Leaves of evergreen plants are not shedded seasonally. The shedding takes place over a period of three or four years in some conifers.

The anatomical structure of the leaf is as follows:

Upper and Lower Epidermis	- Surface layers of the leaf
Palisade Parenchyma	- Layers of elongated cells rich in chloroplasts (colored plastids containing chlorophyll)
Spongy Mesophyll Parenchyma	- Leaf tissue between the two epidermi layers, upper and lower, consisting of chloroplast containing cells
Stoma	- Small pores or openings in the leaf surfaces controlled by guard cells by which water, ygen, and carbon dioxide are exchanged
Vascular Bundle	- Leaf vascular bundles are located in the spongy mesophyll. This is the water and food conducting plant tissue



4. The Flowers of Plants

Flowers, like any other part of the plant, vary in structure, size, and composition. They may be regarded by botanists as specialized shoots. Some flowers may resemble stems, whereas others may resemble leaves. Most flowers are either involved directly or indirectly in plant reproduction. They develop from buds as do shoots; therefore, they are specialized branches of a plant.

Flower Structure

1. Complete flower parts are as follows:

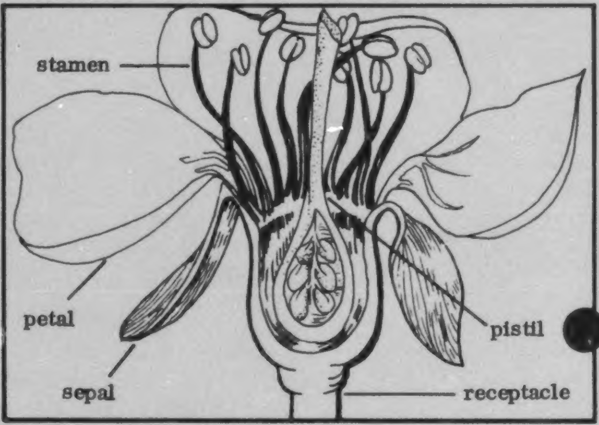
   a. Sepals - All the sepals together are known as the calyx. They are usually small, green, leaf-like parts that protect the petals.

   b. Petals - These parts are located inside the sepals and are considered the showy part of the plant. Petals are usually colored. All the petals are known as the corolla.

   c. Stamens - The stamens are found inside the petals. They consist of a filament or slender stalk that supports the anther where the pollen grains form.

   d. Pistil - A pistil(s) is(are) located in the center of the complete flower. The parts of a pistil consist of an ovary where seed are formed, style which is a tube-like part between the ovary and stigma, and the stigma which is an enlarged feathery or sticky area that catches the pollen grains.

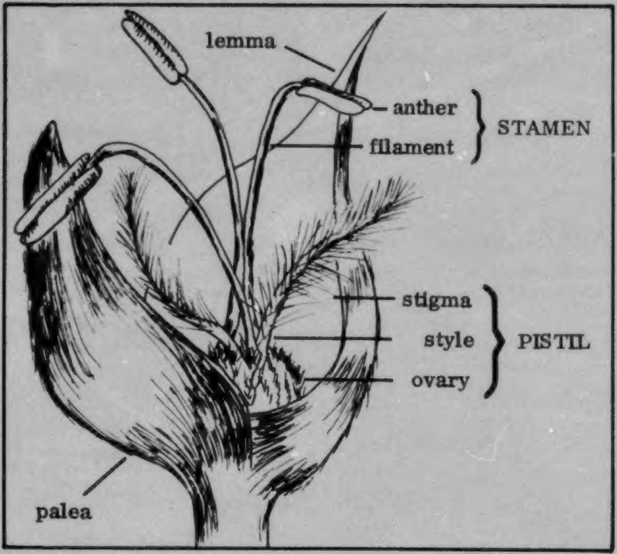
Plants such as peas, alfalfa, and clovers have complete flowers.



2. Incomplete flowers have one or more of the principal parts missing. For example, in oats the sepals and petals are missing. This is true with all small grain plants. Some plants such as corn, squash, asparagus, and strawberries produce flowers that lack either the stamens or pistil. These are known as imperfect flowers. If the flower contains both the stamens and pistil it is said to be perfect.

   In addition to the stamen and pistil, the small grain plant flower has bracts (lemma) that enclose the grass flower. The upper bract is the palea.

3. The differences between monoecious and dioecious plants are due to flower structure. Monoecious plants have flowers containing stamens and pistils in different locations on the plant. Melon, corn, squash, and trees such as oak and walnut are some types of monoecious plants. Dioecious plants such as strawberries, asparagus, spinach, and willow trees are examples of this type of plant. Flowers with stamens and flowers with pistils are produced on different plants.



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SUGGESTED STUDENT ACTIVITIES

1. Underline the word True if the statement is true or underline the word False if the statement is false.

   a. Stolons grow horizontally below the ground surface. True or False?
   b. Xylem conducts plant food materials through sieve tubes. True or False?
   c. Corms are underground stems that are fleshy and short with a few nodes. True or False?
   d. A simple leaf consists of one blade per petiole. True or False?
   e. Plant growth is the result of cell division and enlarging. True or False?
   f. Both plants and animals use protein, fats, and carbohydrates for energy and growth. True or False?
   g. Protoplasm is the living matter of the cell. True or False?
   h. The plant originates from a fertilized egg. True or False?
   i. Root hairs are found on the part of the plant root near the stem. True or False?
   j. One of the major functions of the stem is to control the transport of materials between the roots and leaves. True or False?

2. Completion

   a. The __________ layer is where the branches and leaves separate from the plant.
   b. The vascular system contains __________ and __________.
   c. The outermost layer is known as the __________.
   d. The major parts of a plant are: (1) __________, (2) __________, (3) __________, and (4) __________.
   e. __________ is the total protoplasm in the cell except the cell nucleus.
   f. A group of cells in the plant that vary in size and structure are known as __________.
   g. The growth tissue found near the tips of roots and bud terminals is known as __________ tissue.
   h. The __________ is a tissue located between the epidermis and stele.
   i. __________ or nonwoody plants have stems that contain some chlorophyll.
   j. A collective term used for the sepals is the __________.
   k. The pollen producing part of the flower is known as the __________.

3. Discuss the following questions:

   a. Compare plant and animal growth.

   b. Discuss cell structure and its importance to plant life.

   c. What is the difference between permanent and meristematic tissues?

   d. Discuss the factors that influence root growth.

   e. What are the major parts of a stem and what is the function of each?

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HOW SEEDS GERMINATE

The seed performs three very important functions:

It is a way of survival for the plant species. The plant life cycle begins with the seed which produces a plant with exact or very similar characteristics of the parent plant. A single plant from a single seed may produce hundreds or thousands of seed. For example, one kernel of wheat may produce a plant that produces a thousand seed, and a single tobacco seed can produce a plant that produces a million seed. Millions of pounds of seed are produced annually for planting new crops, which in a way is the survival of the species.

It furnishes food for humans and other living creatures. Small grains, many nuts, beans, peas, and cottonseed are examples of seed that are used as food and feed. Food is in the form of cereals, beverages, breads, pastries, syrups, cooking oils, and salad dressings.

Seed provide raw materials for the development and use of numerous products that are used in the home and surroundings. Certain medicines, pesticides, and construction materials (paint oils and plastics) are made from the different parts of seed.

Two Classes of Crop Seed

The two classes of crop seed are dicotyledons, or dicots, and monocotyledons, or monocots. Bean seed are typical of dicots, and corn seed are typical of monocots. Leguminous crops (alfalfa, beans, and peas) are dicots. Small grains, grasses, and many pasture weeds are monocots. A comparison of these two seed is as follows:

BEAN
(dicot)

Testa (seed cover) with hilum - place seed is attached to stalk
Micropyle - visible opening through which pollen tube grows
Two cotyledons (seed leaves) - food for seedling
Large embryo - young plant formed in the seed
No separate endosperm - starchy part of seed
Plumule - bud or shoot of an embryo, fairly large, leaves folded
Fruit - a pod with many seeds
Hypocotyl - part of embryo axis below cotyledons
Radicle - lower part of hypocotyl which grows into primary root of seedling - similar to monocot
Wall (seed coat)
Epicotyl - part of embryo axis above cotyledons
Dicots - inactive hypocotyl

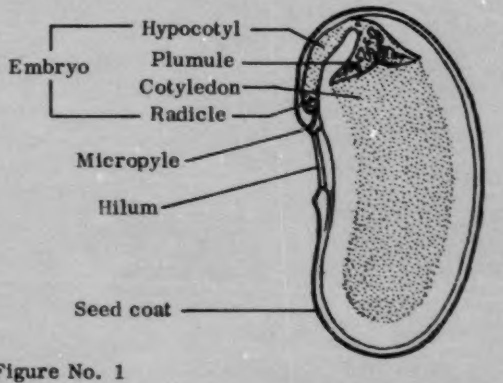


Figure No. 1

CORN
(monocot)

Hilum - covered by fruit coats
One cotyledon
Small embryo
Large endosperm - food for seedling
Plumule - rather small, leaves rolled
Fruit - single grain with one seed
Radicle - similar to dicot primary root
Wall (seed coat)
Pericarp - a wall or ovary around kernel
Coleoptile - cylinder type structure or sheath encasing shoots of grass plants
No hypocotyl arch to push cotyledons and leaf portion through soil

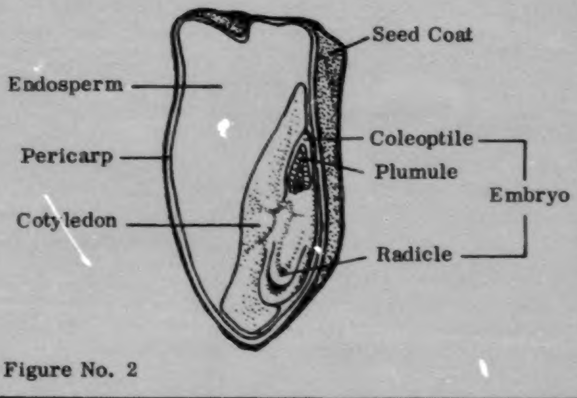


Figure No. 2

Conditions Necessary For Seed Germination

There are four factors that are considered very important to proper seed germination. These factors are: viable seed, moisture, temperature, and oxygen.

1. Viable Seed - In order for seed to germinate, they must be viable; that is, the seed embryo must be alive.

2. Moisture - An ample supply of moisture for seed to germinate. However, the moisture content of seed may range from 26 percent to 75 percent. For example, small grains germinate when the seed moisture is about 50 percent. Grain sorghum and Sudan grass will germinate when the seed contains 26 percent moisture. Soybeans will not germinate until the moisture content reaches about 75 percent.

3. Temperature - Most crop seed germinate at a temperature ranging from 68 to 86 degrees F. These are considered ideal temperatures. Many field crop seed will germinate at temperatures ranging from 32 to 120 degrees F. Temperatures that some common crop seed will germinate are:

   a. Wheat, rye, barley, and oats will germinate just above freezing.
   b. Field peas, alfalfa, soybeans, flax, and some clovers will germinate at about 40 degrees F.
   c. Sorghum and corn germination temperature is about 48 degrees F.

4. Oxygen - Most seed need oxygen to germinate, and some require less oxygen than others. For example, rice seed will germinate when covered with water. Other small grain crops and cotton will not germinate if oxygen is not available. Oxygen deficiency can be increased by planting the seed very deep. The lack of oxygen can cause the seed to remain dormant for several years. Pure oxygen is harmful to seed in a similar way as it is harmful to man.

   Light may be considered an important factor in the germination process. However, it may not be considered as important as moisture, correct temperature, and oxygen for seed germination. Some types of tobacco and grasses require a certain amount of light for seed germination. The grasses that germinate better under adequate light are: Bermuda grass, Kentucky grass, bentgrass, slender wheatgrass, and Canada grass. Most American varieties of tobacco will germinate in the absence of light. Some seed such as pigweed and thorn apple will germinate in total darkness.

Germination of a Dicot and Monocot

Germination occurs when the young dormant plant or embryo begins to grow. Seed must have adequate moisture, favorable temperature, and sufficient oxygen or air before and during the germination process. The steps in the germination process are as follows:

1. The first step is the absorption of water and oxygen into the seed. This process causes the seed to swell and increase in size.

   a. Enzymes are secreted at this point of the process. Their main function is to convert the insoluble starches into sugars.
   b. Soluble sugars dissolve in water and are used as a source of food for the tiny plant or embryo.
   c. As the seed swells, the seed coat is ruptured, permitting the young root or radicle to grow downward. The differences in the germination process between a dicot and monocot are:

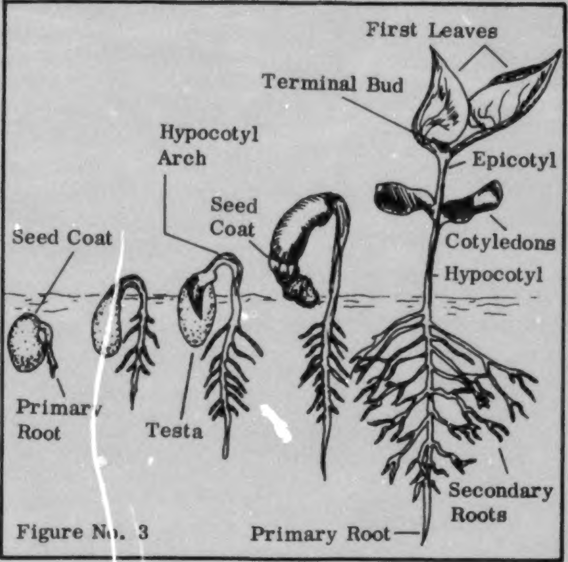


Figure No. 3

      (1) Dicot - The seed coat or testa splits near the hilum, and the young root becomes the primary root which forms branches.
      (2) Monocot - The young root breaks through the coleorhiza or sheath. This first root system is temporary and is replaced later with an adventitious root system.

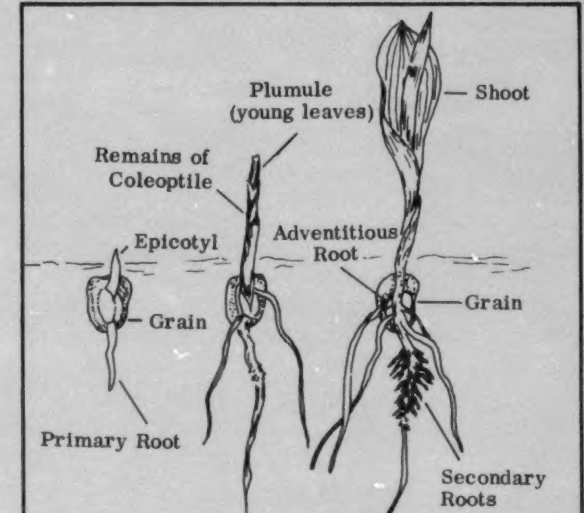


Figure No. 4

2. The upper part emerges from the soil or seed bed. The difference between the dicot and monocot emerging is:

    a. Dicots - The hypocotyl elongates as it curves forming an arch pulling the cotyledons upward; the arch straightens after passing through the surface.
    b. Monocots - The tight roll of leaves (pointed bud), the plumule, pierces the soil as it grows upward and the first true leaf appears.

3. After new leaves are formed, food is manufactured through the process of photosynthesis. The formation of new leaves in the dicots and monocots is as follows:

    a. Dicots - As the hypocotyl arch straightens, the cotyledons spread apart and serve as leaves by transferring food to other parts of the plant. The plumule becomes exposed to air and light. Leaves develop on the plumule and the cotyledons shrivel as their stored food is used by the seedling plant. The stem, or epicotyl, and leaves continue to grow after shedding the cotyledons.
    b. Monocots - After the plumule emerges, the first true leaf is formed and food production takes place in the new leaves. At this point the food supply has been exhausted from the endosperm and the plant begins to manufacture its food through photosynthesis. In monocotyledonous plants the food supply (endosperm) is composed primarily of starch.

4. The formation of the root system in dicots and monocots is as follows:

    a. Dicots - Branch roots form on the primary root to make a permanent root system of dicotyledonous plants.
    b. Monocots - As mentioned in c (2), the first root system is temporary in monocotyledonous plants. New secondary or permanent roots appear on the nodes below the ground surface and the original root produced by the seed dies.

Seed Germination Summary - Dicot and Monocot

Dicot

1. Seed absorbs water.
2. Radicle begins growth by breaking seed coat, grows downward, anchors plant.
3. Hypocotyl elongates and forms hypocotyl arch (in pea, epicotyl arch) that pushes up, pulling cotyledons through the soil.
4. Seed coat is either pulled from cotyledons in the ground or falls to the ground after cotyledons emerge.
5. Cotyledons turn yellow, dry up, die and fall from the plant after plant leaves are formed.
6. Hypocotyl elongation is prevented or controlled by growth hormones.

Monocot

. Seed absorbs moisture causing the radicle to begin growth. The radicle covering, the coleorhiza, bursts open the pericarp, which is the ovary wall surrounding the kernel in corn.

2. The coleorhiza stops growing and ruptures, permitting the radicle to emerge. As the radicle grows into a primary root, it anchors the plant to the soil.
3. The shoot part of the grass plant emerges encased in a cylindrical sharp-pointed plant part known as the coleoptile.
4. As the mesocotyl elongates, it pushes the point of the coleoptile through the soil. The hypocotyl is inactive; therefore, it does not elongate. In many of the grass-type plants the coleoptile elongates.
5. When the tip of the coleoptile is exposed to sunlight it stops growing due to the action of a growth hormone, but it stimulates the growth of the plumule (young leaves). The growth breaks open the coleoptile and leaves appear.
6. A second root system develops at about the time the coleoptile appears above ground. These roots which are at the base of the coleoptile are known as nodal or adventitious roots.

Seed Dormancy

As the plant's life activities begin to slow down and the seed become mature, they tend to enter a dormant stage. During this period the seed can remain vital yet inactive during winter and summer. Seed in some crops fail to germinate immediately after they reach maturity because they must go through an "after - ripening stage". Wheat, barley, oats, and some wild plants must pass through a period of inactivity before germination will take place.

The causes of seed dormancy are:

1. Hard and thick seed coats prevent the absorption of water and the intake of oxygen. Many of the legumes have hard seed coats.

2. Embryos have not passed through all developmental stages in some seeds even though they are mature. For example, in small grain crops the seed must pass through an after - ripening period before they will germinate.

3. Some seed coats interfere with the intake of oxygen. Dormancy in oats and barley is partly due to the lack of the seed absorbing oxygen.

4. Embryos are immature in some seed at harvest; therefore, a maturing period is necessary before the seed will germinate.

5. Some seed mature in the fruit but they will not germinate until they are released from the parent fruit. For example, a tomato seed matures in the fruit but remains dormant until extracted and placed in a favorable environment for germination.

The dormancy period of hard seed is interrupted by scarification of the seed coat. Seed coats can be scratched or broken by blowing and/or rolling the seed against an abrasive surface so that the seed coat is more permeable to water.

Conditions That May Affect Seed Germination

1. Mechanical Injury - Seed with damaged seed coats will either germinate abnormally or fail to germinate. Insects,

rodents, heat, and mechanical harvesting may affect or damage the seed coat.

2. Disease - Many diseases are caused by fungi or bacteria which affect plants. Seed become contaminated by air, water, and insects as they carry spores and bacteria to the plants.

3. Storage Conditions - Seed may become completely dehydrated if stored in a location that has high summer temperature due to artificial winter heating. Places that are too damp cause mold and other fungi conditions. Cool temperature and low moisture is ideal for seed storage.

4. Old Seed - Some seed will not germinate if it is over six months old. Most all crop seed over a year old will not germinate, nor will fresh seed. However, some crop seed will germinate when over a year old if the moisture content and temperature are low. The maximum period that seed remain viable is from two to ten years.

5. Temperature Too Cold - Low temperature causes water to be absorbed slowly. The plant may use the stored food before it grows enough to manufacture its own food if the temperature is low.

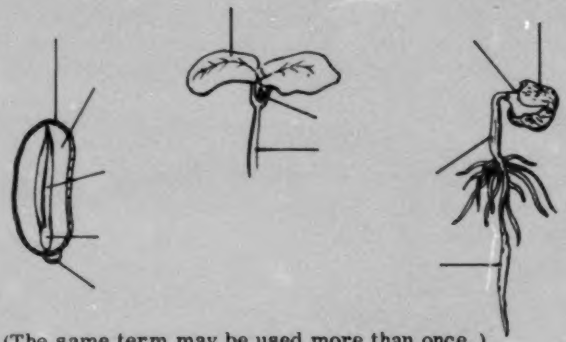
6. Hard Seed Coat - Some plants produce seed with a h seed coat. The seed coat will not permit water to enter the seed and bring about germination until the tough coat is scarified.

7. Drying Out of Soil - Water must be readily available to the seed for germination to take place. The seed will not germinate if the chemical processes that change the insoluble starches to soluble sugars fail to take place. The packing of a seed bed aids germination by preventing soil drying.

8. Planting Too Deep - Seed that are planted too deep may germinate, but the plants will exhaust their food supply and die before reaching the surface. They cannot manufacture food without light.

SUGGESTED STUDENT ACTIVITIES

1. List the proper term on the following drawings:



(The same term may be used more than once.)

Hypocotyl Endosperm Cotyledon Caruncle

Seed Coat Root Terminal Bud

2. List the three important functions performed by the seed.
   a.
   b.
   c.

3. Discuss seed dormancy.

4. Use the summary in discussing the germination of a monocot (corn).

5. Completion
   a. The two classes of crop seed are __________ and __________.
   b. The seed testa is known as the __________ __________.
   c. The lower part of the hypocotyl which grows into the primary root is referred to as the __________.
   d. The four factors that are considered very important to seed germination are: __________, __________, __________, and __________.
   e. Germination occurs when the young dormant plant __________ begins to grow.
   f. The hypocotyl arch is found in __________ seeds.
   g. Insects, rodents, and machines can cause __________ damage to the seed coat.
   h. Very high temperatures will cause seed to __________.
   i. Seed are used as human __________ and animal __________.
   j. Leguminous crops are classed as __________.

6. Matching: Match the proper word with the statement by placing the correct letter in the parentheses.

Word

a. Dicotyledon	d. Plumule	g. Enzymes
b. Endosperm	e. Cotyledon	h. Coleoptile
c. Hypocotyl	f. Radicle	i. Pericarp

Statement

Part of embryo axis below cotyledon ( )
Lower part of hypocotyl which grows into primary root ( )
Serves as food for young seedling ( )
Starchy part of a seed ( )
Bud or shoot of an embryo ( )
Class of crop seed that includes beans and peas ( )
Protein substance that converts starches into sugars ( )
The ovary wall surrounding a kernel of corn ( )
The shoot part of a grass plant is encased in a cylindrical sharp-pointed plant part ( )

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HOW PLANTS MAKE, USE, AND STORE FOOD

After the tiny crop plant emerges and enters the seedling stage, it soon ceases to be dependent upon food provided by the seed. The young seedling becomes self supporting by manufacturing its own food from certain raw materials. The young plant may be thought of as a factory, with all its auxiliary systems of transporting, processing, and distributing materials. The raw materials entering the plant are processed to provide the needs of the plant itself, and also to provide humans and animals with food and fiber.

The process the plant uses to manufacture its food is known as photosynthesis. This physiological process is performed mainly by the leaves. Even though the process is considered very important to the manufacturer of plant food, it could not be completed without the processes of translocation, osmosis, and chlorophyll formation. Photosynthesis is the process by which carbohydrates are formed in the chlorophyll-containing tissues of plants exposed to light. ("Photo" means light, and "synthesis" means putting together). A more appropriate definition - the process whereby certain living plant cells combine carbon dioxide, water, and light in the presence of chlorophyll and certain enzymes, to form carbohydrates -- mostly glucose, a simple sugar, and to release oxygen. The leaves of a plant are considered the place where raw plant food materials are transformed or manufactured into a form of plant food that is either used or stored by the plant; therefore, they are the main parts of a plant where photosynthesis takes place.

Each part of the leaf and its function is important to the making of plant food. The parts and their functions are:

Part	Function
1. Cuticle	A waxy protective covering on external part of plant
2. Lower Epidermis	Cell layer on one side of leaf interspersed with stomata. Permits exchange of CO_2 and H_2O
3. Stomata	Openings (pores) admitting and releasing CO_2 and O_2 giving off H_2O
4. Upper Epidermis	Layer that prevents loss of water. It may have a waxy or hairy appearance
5. Palisade Cells	Food making cells rich in chloroplasts (colored chlorophyll)
6. Spongy Layer	Food making, area for gaseous exchange and transpiration
7. Chloroplasts	Contain colored chlorophyll - enable food making in the chlorophyllous cells
8. Air Spaces	Transport air and water vapor
9. Veins or Vascular Bundle	Transport water and food stuff - give leaf support

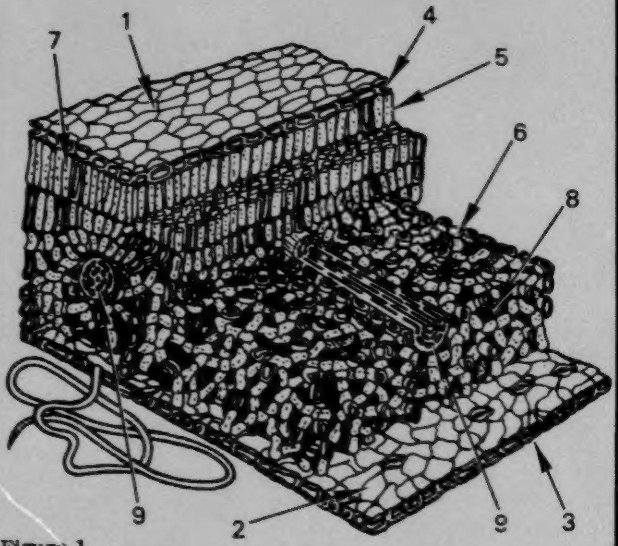


Figure 1

The Method By Which Photosynthesis Takes Place

1. Carbon dioxide (CO_2) is taken in by the leaves through small openings (stomata) which are in the outer layer of the leaf cells (epidermis). These openings (pores) are closed by guard cells when photosynthesis ceases. Most of the closing process takes place in a limited amount of light.

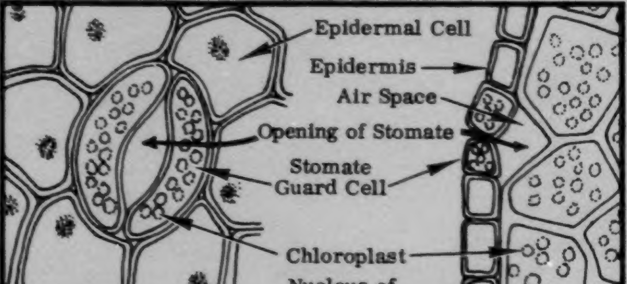


Figure 2

2. Carbon dioxide (CO_2) combines with water (H_2O) and forms a simple carbohydrate. The water and minerals are absorbed from the soil by roots and carried up the stem's xylem tubes to the leaves. The combination of CO_2 and H_2O is caused by energy from light working through a complex system of enzymes.

3. The chemical changes that take place in forming plant food are:

$$6CO_2 + 12H_2O + \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

or

$$\text{Carbon Dioxide} + \text{Water} + \xrightarrow[\text{Chlorophyll}]{\text{Light}} \text{Sugar} + \text{Water} + \text{Oxygen}$$

   a. Twelve molecules of water are used in photosynthesis.
   b. Six molecules of water are produced. (not derived from process)
   c. Six molecules of oxygen are derived from splitting water molecules.
   d. The oxygen in the glucose (sugar) is derived from splitting the CO_2 molecules.
   e. Sugars (fructose, sucrose, maltose), starches, and cellulose are other organic materials that can be produced in the photosynthesis process.
   f. The two types of chlorophyll found in crop plants are a and b. Chlorophyll is made up of chemical structures that serve in the chemical reaction which takes place in the photosynthetic process. The color of chlorophyll a is bluish-green and chlorophyll b is yellowish-green. The yellowish green color may also be a chlorophyll deficiency in plants. The letters a and b are symbols used to identify the different types of chlorophyll.

4. Light energy is necessary for photosynthesis, but starch may be changed to sugar during the non-daylight hours of each day; therefore, plants use the soluble sugars and grow at night. Numbers 1, 2, and 3 above explain that plants produce and use food sugars for growth during daylight hours.

Nutrients and Water Absorbed and Distributed by The Plant

1. Absorption

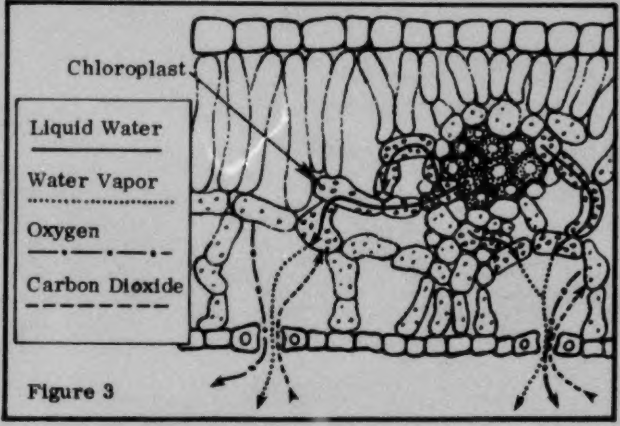
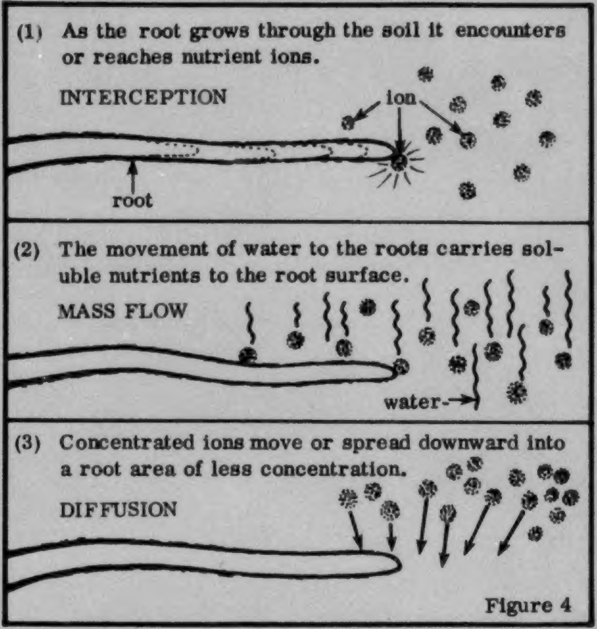


Figure 3

   a. Carbon dioxide moves into the plant leaf as a gas through the leaf openings as stated in the method by which photosynthesis takes place. This process occurs when CO_2 is needed in the plant. The gas (CO_2) passes from the air -- a higher concentration -- into the leaf, a lower concentration. As stated previously, the CO_2 entrance is made through the stomata.

   b. Osmosis is another of the absorption processes. Most of the water enters the root through the walls of the root hairs (epidermal cells) of plants due to osmosis. At this stage of water movement, it passes to the xylem tubes and up the stem to the leaves and other plant parts. The concentration of water is reduced as the plant uses it in photosynthesis and transpiration. Water moves from a higher concentration through a differentially permeable membrane to a lower concentration, the plant root; therefore, water entering the plant root is by diffusion. A differentially permeable membrane is one which controls substances as they pass through it. The cells become turgid (swollen) and the plant stands straight. The leaves are crisp when the cells are filled tight with water.

   c. In order for a nutrient ion to pass from a soil solution into a root hair it must get to the surface of the root for absorption. The three main ways this process takes place are as follows:



(1) As the root grows through the soil it encounters or reaches nutrient ions.

INTERCEPTION

(2) The movement of water to the roots carries soluble nutrients to the root surface.

MASS FLOW

(3) Concentrated ions move or spread downward into a root area of less concentration.

DIFFUSION

Figure 4

Plant nutrients move from cell to cell after they have been absorbed by the root hairs. As nutrients reach the tubes (xylem) that conduct the water to the leaves, they move into the leaves, where carbon dioxide and water are present to produce plant food (sugar) through the process of photosynthesis.

Manufactured food materials are transported from the leaves by a portion of the vascular tubes (phloem) to various parts of the plants where food is converted into carbohydrates, fats, proteins, cellulose, hemicellulose and lignin (component of the woody part of the fibrovascular bundles in plant tissue). These materials are for the building of new cells or repairing old ones.

To a limited extent, plant nutrients and water may be taken into the plant through leaves and stems. For example, nitrogen is sometimes applied to leaves in the form of a spray.

Use of Food By Plants

One of the very important ways a plant uses its food is through the respiration process. The organic compound:

$$\underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2} \longrightarrow \underset{\substack{\text{carbon}\\ \text{dioxide}}}{6CO_2} + 6H_2O + \text{energy}$$

Explaining the process in another way, sugar plus oxygen is broken down releasing energy, carbon dioxide, and water. The energy is released to the plant cell. This process is known as aerobic (respiration in the presence of free oxygen) respiration.

Respiration in plants is chemically reverse to that of photosynthesis. The process is as follows:

Photosynthesis

A Building Process
Food Manufactured
Sun Provides Energy
CO_2 Taken in Plant
Oxygen Given Off
Complex Compounds Form
Produces Sugars, Starches
Requires Light
Proceeds in Chlorophyll Cell

Respiration

A Destruction Process
Food Consumed
Energy is Released
CO_2 Given Off
Oxygen Used
Simple Compounds Form
Breaks Down Sugar
Goes on Day and Night
Carried on in All Cells

Importance of Respiration

It is estimated that about 25 percent of the sugar manufactured in plant leaves is used for plant energy, and this stored energy is released through respiration. As this energy is released, fats, proteins, sugars, and other products manufactured by photosynthesis are broken down for cell use. This is a continuous process - 24 hours per day. Photosynthesis ceases during the night. CO_2 is released at night, and O_2 is released during the day. Most of the CO_2 is used by photosynthesis during the day.

Respiration is very important in overwintering root plants and crowns of some forages. Under certain wintering conditions (ice coverage) plant tissue may be damaged due to toxic effects of carbon dioxide. Respiration also causes the heating of grain, hay, and silage, as energy is released. Moisture and temperature are the two main factors that affect the rate of respiration in stored crops. Low temperature and low humidity prolong the life of seed; therefore, it is necessary to use practices to reduce the rate of respiration to keep seed viable (alive and able to germinate).

Transpiration or Evaporation of Moisture

Water vapor loss by the plant occurs mainly through the leaves. Most of the water vapor escapes through the stomata, but it may take place on any part not covered by a cuticle or cork layer. If the plant leaves are not well supplied with water, they become limp, causing the plant to wilt. The wilting of plants can be caused either by the movement of water in reverse (the water moves out of the root into soils that are high in soluble salts) or the roots failing to absorb water as fast as it is evaporated through the leaves.

The amount of water lost by transpiration varies due to the following factors:

1. Climatic conditions extracting water from the leaves
2. The number and size of the pores on the leaves
3. Leaf water capacity
4. Availability of soil moisture to the plant
5. General plant structure limiting transpiration -- thickened cuticle, waxy covering, sunken stomata, and reduced leaf surface. When water is limited, the stomata guard cells may wilt.

Water requirements vary according to the crop plant. For example, to produce one pound of dry alfalfa it will take about 831 pounds of water; whereas, only 368 pounds of water are required to produce one pound (dry matter) of corn. It also varies according to soil fertility.

The plant uses more water on fertile soils than on poor soils; therefore, transpiration is greater on fertile soil plants. Yet, many plants can control the amount of water transpired to some extent.

The Values of Water to The Plant

1. Cools the plant leaves
2. Provides raw materials used in the photosynthesis process
3. Serves as a medium for transporting nutrients from the soil to plant parts
4. Gives the plant rigidity by keeping the cells expanded
5. Conducts manufactured food from the leaves to all parts of the plant

Uses of Plant Foods

Food manufactured by the plant through the photosynthesis process is used to build new tissue and furnish energy for the plant to carry on its functions. As stated previously, these foods are carbohydrates, fats, and proteins.

1. Carbohydrates are composed of carbon, hydrogen, and oxygen (CHO). They make up almost all the total weight of a plant. For example, 500 pounds of lint cotton contain 425 pounds of carbohydrates, and 1000 pounds of cottonseed contain 263 pounds of carbohydrates. These carbohydrates are sources of plant energy.

2. Fats are also carbon, hydrogen, and oxygen, but the element proportions are different than in the carbohydrates. They are sources of plant energy. Crop seed oils become solids when the melting points are raised (hydrogenated).

3. Proteins are from 75 to 85 percent carbon, hydrogen, and oxygen. They also contain nitrogen and sulphur, and they may contain phosphorus. Proteins are used in plant cell production. Plants are similar to animals in that digestion and assimilation take place in the manufacturing of plant food. Digestion and assimilation may be defined as follows:

> Digestion is the changing of starches, fats, and proteins into a soluble form for plant use.
> Assimilation is the conversion of carbohydrates, fats, proteins, and simpler nitrogenous foods into living material (protoplasm).

Plant Food Storage

Plant food materials that have been manufactured through the process of photosynthesis and not used to build plant tissue or used as energy in plant functions are stored within the plant. The stored materials are found in three basic forms:

1. Carbohydrates, which are starches, sugars, and fructosans (a chain of fructose sugar molecules in many grasses). Starch is usually the most abundant food stored in plants. It is found in great quantities in grains and tubers.

2. Protein is the food material that contains nitrogen. It is found stored in both the plant and its seed. For example, wheat seed protein (gluten), which gives wheat a baking quality, is very important to the diet of man. Cottonseed, soybeans, flaxseed, and peanuts are sources of protein for animal feeds. Alfalfa leaves are also used as a high protein feed.

3. Fats or oils are stored in many types of plant seed. Some of the main oilseed plants are: soybeans, flax, cotton, peanuts, and sunflower. Oils are also extracted from corn, sesame, castor beans, and rape.

Food Storage by Plant Class and Plant Parts

1. Plant Classes

   a. Annuals (plants that live only one year) store food in the forms of seed. Corn, wheat, oats, and beans and many others fit into this class.
   b. Biennials live two years producing seed the second year. They usually store food in the roots the first year. Clovers, sugar beets, and turnips are in the biennial class.
   c. Perennials store food in seed, roots, stems, and other parts of the plant. For example, Johnson grass, Irish potato, and asparagus store food in underground stems. Food is stored in the roots of alfalfa. Orchard grass stores food in the crown bud. Perennials are plants that live from year to year.

2. Plant Parts

   a. Leaves - cabbage
   b. Petioles or leaves - celery
   c. Stems and leaves - onion
   d. Floral parts - broccoli
   e. Buds - brussel sprouts
   f. Ovary wall and contents - green beans
   g. Receptacle of flower - apple

SUGGESTED STUDENT ACTIVITIES

1. Fill in the blanks indicated below to make true complete statements:

   a. "Photo" means __________, and "synthesis" means __________ __________.
   b. Water moves out of the root into soils that are high in soluble __________.
   c. Carbohydrates are composed of __________, __________, and __________.
   d. __________ is an absorption process.
   e. __________ molecules of water are used in photosynthesis.
   f. Carbon dioxide (CO) is taken in by the plant through pores known as __________.
   g. The plant __________ is considered the place where raw plant food materials are manufactured into plant foods.
   h. Fats or oils are stored in plant __________.
   i. About __________ percent of the sugar manufactured by plants is used for plant energy.
   j. The respiration process takes place __________ or __________ hours per day.

2. Select the appropriate word for the statement, and write the correct word(s) in the blank space(s).

   a. Xylem
   b. Digestion
   c. Photosynthesis
   d. Annuals
   e. Transpiration
   f. Carbon dioxide
   g. Protein
   h. Respiration
   i. Chloroplasts
   j. Photosynthesis

   (1) __________ is released at night during the process of photosynthesis.
   (2) __________ is the changing of starches, fats, and proteins into a soluble form for plant use.
   (3) __________ is food material that contains nitrogen.
   (4) __________ store food in forms of seed.
   (5) __________ is the process the plant uses to manufacture its food during daylight hours.
   (6) __________ contain colored chlorophyll and enable food making in the chlorophyllous cell.
   (7) __________ tubes conduct the water from the roots to the leaves.
   (8) __________ in plants is chemically reverse to that of photosynthesis.
   (9) __________ produces plant sugars, and respiration breaks down plant sugars.
   (10) __________ is the movement of water from the leaves into the atmosphere.

3. Define the following terms:

   a. Diffusion -

   b. Aerobic respiration -

   c. Assimilation -

   d. Protein -

   e. Absorption -

4. List the processes of photosynthesis and respiration that explain why respiration is reverse to photosynthesis.

5. Circle the T for true statements and the F for false statements.

T F a. Climatic conditions have no effect on plant transpiration.
T F b. The plant growing on fertile soil uses more water than a plant growing on poor soil.
T F c. Only the leaves of a plant are important in making plant food.
T F d. The food making cells are rich in chlorophyll.
T F e. Most fats and oils are stored in the stems of plants.
T F f. Carbon dioxide combines with water to form simple proteins.
T F g. Plant starch may be changed to sugar during the non-daylight hours.
T F h. Turgid plant cells cause the plant to wilt.
T F i. The movement of water to the roots carries soluble nutrients to the root surface.
T F j. Carbohydrates are composed of carbon, hydrogen, and oxygen.

6. List five values of water to a plant.

a.
b.
c.
d.
e.

7. List by formulas the chemical changes that take place in manufacturing plant food.

NOTES

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CLASSIFICATION OF PLANTS–FIELD CROPS

The study of naming and classifying plants is called taxonomy. The botanical classification of plants is an aid to the taxonomist, agronomist, and agriculturalist in understanding and remembering plants by the similarities and differences found in the structure of their different parts. Plants have been grouped and classified in various ways for many generations. Some of the most common ways of grouping plants are as follows:

Row-crops or cultivated plants.
Cotton, corn, grain sorghums, and soybeans fit into this group.

Broadcast or drilled crops are usually grouped as cultivated and noncultivated crops.
Wheat, oats, barley, and rye are either broadcast or drilled in.

Pasture crops are grouped or classed as sod or hay crops. Bermuda grass, alfalfa, clovers, vetch, lespedeza, bahia grass, and other similar crops are in this group.

There are about 300,000 species of plants that have been identified and classified. About 150,000 species are in the dicotyledon division. In order to use a universal language, the botanical plant names are based upon Latin descriptions which are approved by a Congress or Committee of plant scientists. Carl Linnaeus, a Swedish botanist, developed the present system of plant classification in 1753. If there were no botanical classification to identify and classify plants, many different species would carry one common name. For example, all clovers would be identified as clover, even though crimson clover is a winter annual and sweet clover a biennial.

Botanical Classification of Corn and Alfalfa Plants

Common Name:	Corn
Kingdom:	Plant
Phylum:	Spermatophyta (seed plants)
Subphylum:	Angiosperms
Class:	Monocotyledona
Order:	Graminales
Family:	Gramineae (grass family)
Genus:	Zea
Species:	Mays
Variety:	Reid's Yellow dent

Common Name:	Alfalfa
Kingdom:	Plant
Phylum:	Spermatophyta (seed plants
Subphylum:	Angiosperms
Class:	Dicotyledona
Order:	Fosales
Family:	Leguminoseae
Genus:	Medicago
Species:	Sativa
Variety:	Ranger

Divisions of the Plant Kingdom

There are four large plant divisions. They include:

1. Thallophytes or thallus plants (algae, fungi, and bacteria)--plants having no stems, roots, or leaves.

   a. Algae are green scum found growing on ponds. They contain no chlorophyll.
   b. Fungi are plants that do not contain chlorophyll. Fungi are both beneficial and harmful. These simple nongreen plants include: molds, mildews, yeasts, mushrooms, smuts, and ringworm fungi. The beneficial fungi are used to cure cheese and preserve beverages.
   c. Bacteria are harmful and beneficial. The type that lives on plant nodules and takes nitrogen from the air are beneficial. Other bacteria liberate plant nutrients by rotting plant refuse. Bacteria are microscopic one-cell plants.

2. Bryophytes include liverworts and mosses. They do not produce flowers or have roots. Most bryophytes have no stems or leaves, yet they are considered more specialized than thallophytes. They are also nonvascular plants.

3. Pteridophytes are ferns, horsetails, and club mosses. Like the liverworts and mosses, they are of no economic importance to the crop producer. The ferns in this division are classed or grouped with the tracheophytes or vascular plants.

4. Spermatophytes produce seed or fruit after fertilization takes place in the flowers. They are the most specialized and important plants to the human race and animals; therefore, this division includes the field crops. The division is also called vascular plants or tracheophytes because the vascular vessels transport materials to the plant roots, stems, and leaves.

Seed Producing or Spermatophyte Plants

The two main groups of spermatophytes are classed as gymnosperms and angiosperms.

1. Gymnosperms produce seed not enclosed in an ovary; therefore, they are naked seed. They are considered woody perennial forms which are usually evergreen plants such as pine, fir, spruce, and others.

2. The angiosperms include all the flowering plants. They

are of the greatest importance to agriculture because the cultivated crops are in this plant class. Flowers of these plants produce the fruit or ovary in which the seed are enclosed. Angiosperms are divided into monocotyledonous and dicotyledonous classes. General identification of these two classes is as follows:

> The word "mono" means one and "cotyledon" means seed leaf. A monocot has one seed-leaf, and a dicot has two seed-leaves.

Monocots include the grass family, orgramineae, which includes all the cereal crops and three-fourths of the cultivated forage crops.

Dicots include the legume family, or leguminoseae. They produce their seed in a pod or compartment.

Important Seed Producing Families (With Examples) Classified Under the Monocotyledon and Dicotyledon Divisions

Two important monocotyledon families are:

1. Grass Family (gramineae). Corn, wheat, barley, rye, rice, oats, and other cereal grains; grasses and millets.
2. Lily Family (liliaceae). Lilies, onions, tulips, wild onions, and garlic.

Six important dicotyledon families are:

1. Legume Family (leguminoseae). Beans, peas, peanuts, vetch, lespedezas, alfalfa, clovers, soybeans, and kudzu.
2. Nightshade Family (solanaceae). White potatoes, tobacco, pepper, egg plant, and ground cherries.
3. Mustard Family (cruciferae). Turnips, kale, rutabaga, cabbage, cauliflower, Brussels sprouts, radishes, water cress, and mustard.
4. Morning Glory Family (convolvulaceae). Morning glory, sweet potato, and dodder.
5. Mallow Family (malvaceae). Cotton and okra.
6. Rose Family (rosaceae). Rose, peach, almond, apricot, pear, apple, plum, and strawberry.

Binomial System Used in Classifying Plants

When identifying a plant by its scientific name, it is not necessary to give its entire classification. A specific crop plant can be identified by using the genus and species. For example, purple flowered alfalfa is Medicago sativa, L. Generally speaking, specie corresponds to a person's first name and genus to the last name. In this case Medicago is the last name and sativa the first name. When comparing the names with a person's name, L. refers to the first letter of the last name of the person who first botanically classified and named the plant. Linnaeus was the first to classify alfalfa.

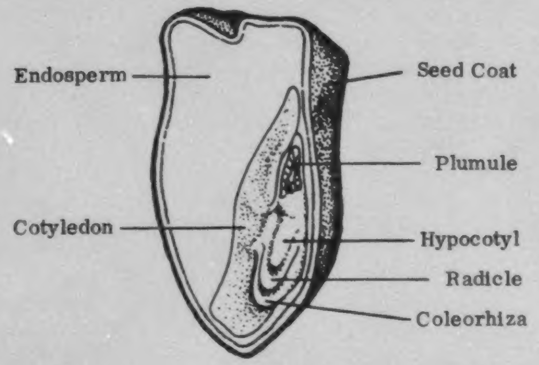
Species are broken down into varieties. Important information to remember about varieties is as follows:

Varieties are developed by the plant breeder; other classifications are not.
Variety is a rank within the species.
Variety is distinguished by capitalized name before the species name. Example, Triumph wheat.

Seed Producing Plants

A comparison of monocot and dicot plant characteristics.

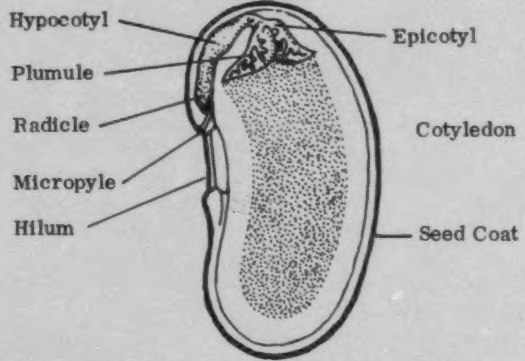
Monocot seed



Cotyledon -one seed leaf not divided into two parts.

Endosperm -(young plant food). Most of seed interior is floury.

Dicot seed



Cotyledons -Two seed leaves that are divided into two conspicuous parts.

Hilum -Scar of seed attachment in some seed. Minute hole may be seen near hilum or micropyle. The micropyle is opening for pollen tube.

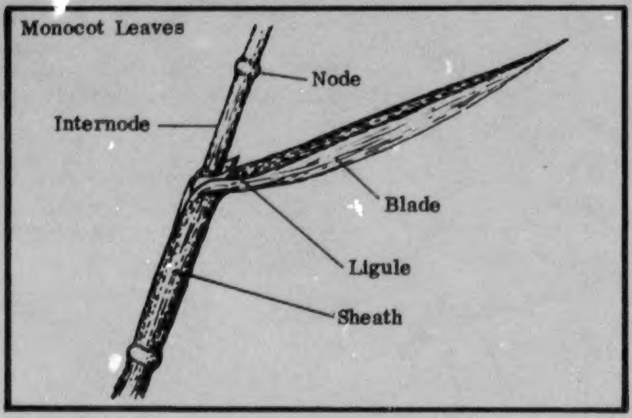
Monocot leaves

Consist of two parts, the sheath that envelops the stem and the blade.

Leaves usually found in two alternate rows on the stem and attached at the node.

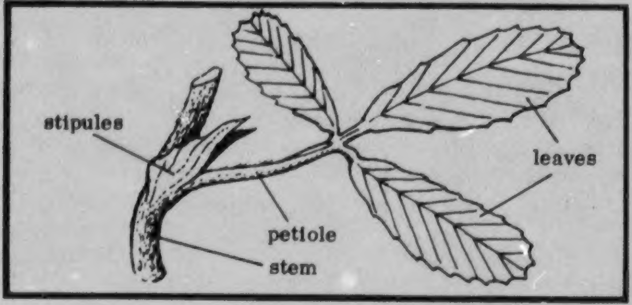
Main veins parallel each other in the leaves.

Monocot Leaves


Node
Internode
Blade
Ligule
Sheath

In some monocots, leaves have auricles (claw-like growth of the leaf around the node) and a ligule (tissue-like projection located between the sheath and stem where the sheath and stem join).

Dicot leaves

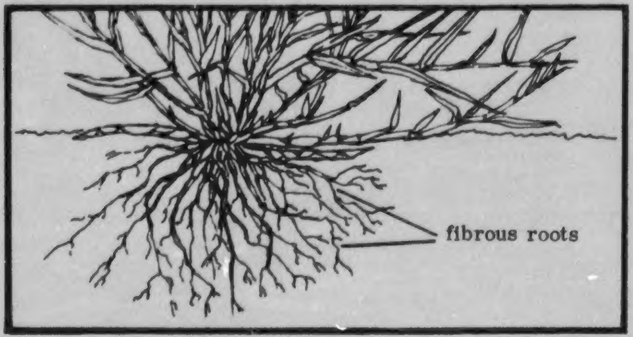

stipules
leaves
petiole
stem

Leaves alternate on the stems and netted-veined with either prominent central midrib or single midrib. Veins branch out from midrib.

Simple leaf-blade of one piece. Compound leaf with many lobes (leaflets) that join at the base of the leaf stalk (petiole).

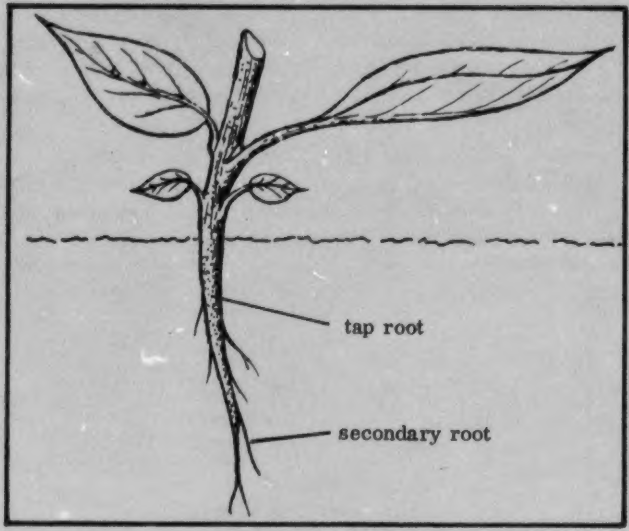
Leaflets are usually rounded and are either smooth or hairy. The appendages (stipules) are found at the base of the leaf stalk.

Monocot roots


fibrous roots

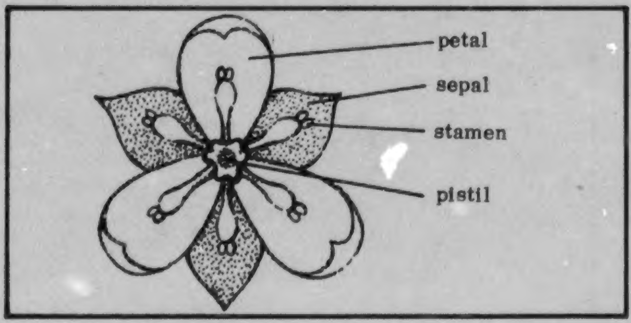
Plants lack a principal root. They have many fibrous roots of about the same size. The roots do not have nodules. Fibrous roots are also known as adventitious roots.

Dicot roots

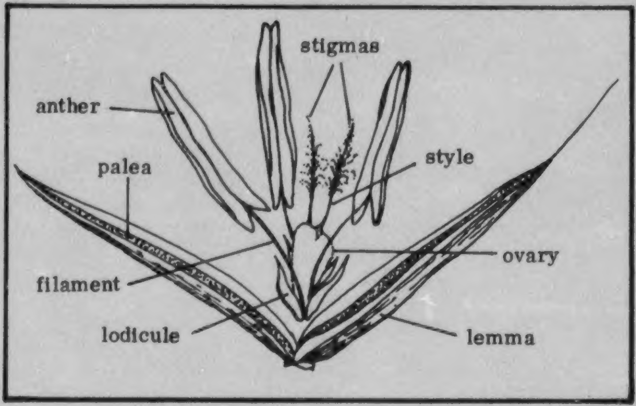

tap root
secondary root

Dicots have large primary roots (tap roots) with secondary roots. They usually have nodules on the roots, especially in the legume family.

Monocot flowers


petal
sepal
stamen
pistil

Flower parts -- petals and sepals are usually arranged in threes.

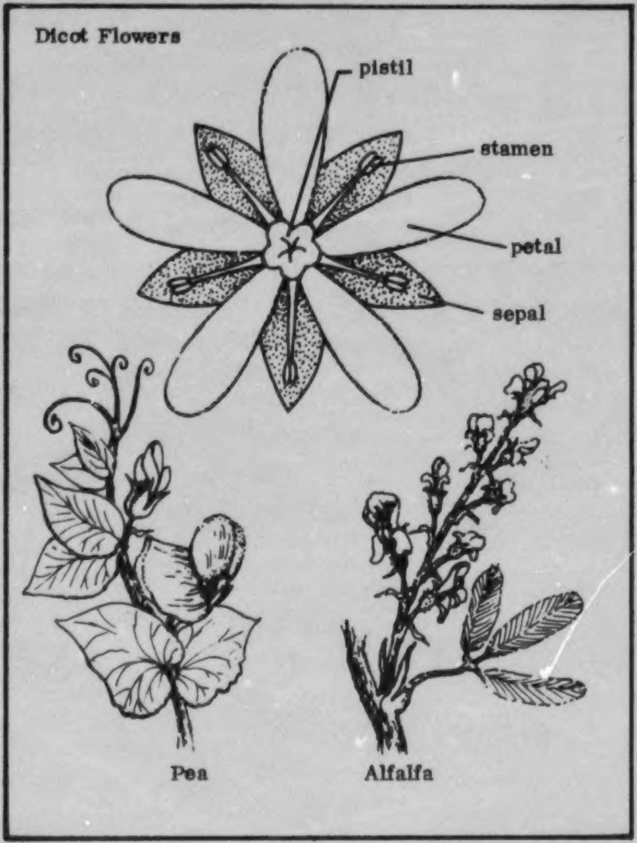

stigmas
anther
style
palea
ovary
filament
lodicule
lemma

In the grass family, the flower parts are in a compact or open inflorescence (the flowering part of the plant). The perfect flowers are usually arranged in a spikelet. The stamens may vary in number, but three is the usual number found. Bracts (palea and lemma) help support the stamens.

Dicot flowers

Flower parts -- petals and sepals and usually other parts are arranged in twos, fours, and fives. Stamens and carpels (stigma, style, and ovary) may be identified in different arrangements.

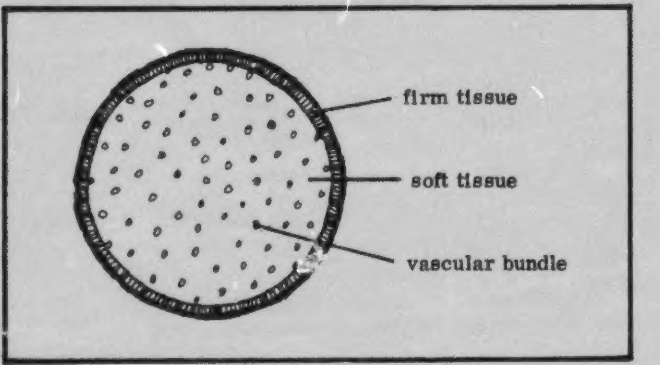
Flowers may be arranged butterfly-like as in field crop legumes. In most clovers flowers are arranged in heads and in alfalfa in spikelike racemes. A typical legume flower may have five sepals and ten stamens.


Dicot Flowers

Monocot stems

Stems are either hollow or pithy, cylindrical, and made up of nodes and internodes.

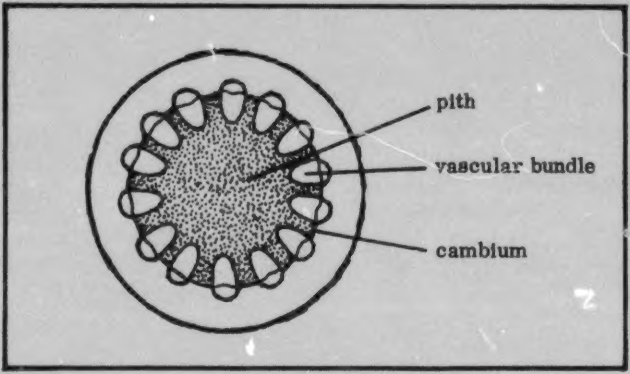
Vascular bundles are usually scattered (lacking definite arrangement in the stem).



Dicot stems

Vascular bundles are arranged in a ring or circle in the stem. The cambium layer is also located in a ring around the vascular bundles.

The stem is usually pithy in crop plants and lacking distinct nodes.



Classification of Field Crops According to Use

Cereal crops - Cereal crops are grown to furnish edible seed. They are considered grass plants. Seven of the most important crops are: corn, wheat, rice, grain sorghums, barley, oats, and rye.

Seed legumes - The most important legumes grown for their edible seed are: soybeans, peanuts, field beans, field peas, and cowpeas.

Forage crops - Grasses and legumes that are grown as feed for animals are considered to be forage crops. The feed may be in the form of silage, pasture, harvested hay, and fodder. Grass forage crops are: corn, sorghum, alfalfa, oats, barley, hay grasses, and clovers.

Root crops - Sweet potatoes, rutabagas, beets, and turnips are the most common root crops grown as food and feed.

Fiber crops - Raw materials for producing textiles, rope, and twine are produced from cotton, flax, and hemp. Cotton has always been recognized as the most important fiber plant.

Sugar crops - Sugar plants include sugar beets, sugarcane, and the sweet sorghums. Sugarcane and sugar beets furnish the bulk of sugar and syrup production in the United States. Sweet sorghum and corn are used to produce syrup.

Oil crops - Cottonseed, soybeans, flax, peanuts, and castor beans are the most important crops grown to produce oils for human consumption and commercial use.

Tuber crops - Irish (white) potatoes are thickened underground stems. It is a tuber of great importance in the United States. The Jerusalem artichoke is also an important tuber.

Stimulant crops - The most important stimulant crops are tobacco, coffee, and tea. Tobacco is the most important stimulant crop grown in the United States.

Fruit, vegetable, and timber crops - These three crops are usually not referred to as field crops, but they are considered major crops in certain areas.

Special Use Classification

Green manure crops - Crops included in this group are: clovers, vetches, cowpeas, soybeans, and other similar crops. These crops are plowed under green for the purpose of making the soil more productive.

Cover crops - Crops that are planted to protect the soil against wind and water erosion and fertility losses are crimson clover, rye, vetch, oats, wheat, and seasonal grasses. Buckwheat is also used in some areas as a cover crop.

Emergency crops - Crops planted in the place where crops have failed are known as catch or emergency crops. They are usually quick growing crops used for feed or green manure. Sudan grass, rye, and millet are examples of catch crops.

Soiling crops - Crops that are usually cut green and fed to livestock without curing are sorghums, alfalfa, corn, and soybeans.

Silage crops - Corn and sorghums are generally used for silage, but other crops such as soybeans, cowpeas, clovers, grasses, and sunflowers are used. The crop is preserved in a succulent condition by passing through a stage of partial fermentation.

Companion crops - Grasses, clovers, peas, and beans are often sown with other crops.

Thermo Classification

Warm season crops - Crops requiring warm climates are grown in the southern half of the United States. They are found in the subtropical crop belt, cotton belt, and the southern part of the grazing and irrigated crops region.

> Examples are: cotton, tobacco, field peas, sorghums, and citrus fruit.

Cool season crops - Most of the major cool season crops are grown in the northern half of the United States. They are found in the wheat belts, corn belt, and hay and dairy regions.

> Examples are: most cereals, tubers, and certain fruit (apples) crops.

Life Span Classification

Another method used in grouping plants (field crops) is on the basis of their growth characteristics.

The botanical classification of plants is probably the most important method used for identifying and grouping of all known plants. The binomial system which is made up of the genus and species identifies the plant scientifically.

> Annuals are plants that complete their life cycles in one year. Annuals are propagated from seed. They mature, produce seed, and die in a single season.
>
> > Summer annuals such as corn, beans, peas, and sorghum are planted in the spring; they mature, produce seed, and die before fall.
> >
> > Winter annuals such as winter wheat, winter peas, and vetch are planted in the fall and the plant dies after the seed is produced in the summer.
>
> Biennials live two seasons. The first year they produce vegetative parts and store food. The stored food is used the second year for growth and seed production. After the seed is produced the plant dies.
>
> > Examples of biennials are sweet clover, cabbage, beets, and carrots.
>
> Perennials are plants that live more than two seasons. Most perennials develop the first season, but do not produce flowers until the following season or later.
>
> > Perennial crops are white clover, bermuda-grasses, Sericea lespedeza, and many others.
> >
> > Cotton will grow as a perennial if the climatic conditions permit. If warm weather continues throughout a winter season in certain areas of the United States a second crop of cotton can be produced from stumps of the first crop.

SUGGESTED STUDENT ACTIVITIES

1. Match the appropriate words or phrases with the common terminology words.

   a. Spermatophyla ( )
   b. Mays ( )
   c. Monocotyledona ( )
   d. Reid's Yellow dent ( )
   e. Zea ( )
   f. Angiosperma ( )
   g. Gramineae ( )
   h. Graminales ( )
   i. Corn ( )

   (1) Variety
   (2) Family
   (3) Genus
   (4) Common name
   (5) Species
   (6) Order
   (7) Phylum
   (8) Class
   (9) Subphylum

2. Completion

   a. __________ are plants having no roots, stems, or leaves.
   b. The grass family (gramineae) is classed as __________.
   c. A monocot has __________ petals and sepals arranged into threes.
   d. Dicot stems have the vascular bundles arranged in a __________ or __________ in the stem.
   e. __________ crops are grown to furnish edible seed.
   f. __________ crops are plowed into the soil to make it more productive.
   g. Warm and cool season crops are in the __________ classification of crop plants.
   h. Alfalfa is in the __________ family.
   i. Corn and other grass plants are in the __________ class.
   j. __________ (class) plants produce their seed in a pod or compartment.
   k. The study of naming and classifying plants is called __________.
   l. The Swedish botanist __________ (name) developed the present plant classification system.

3. Discuss the following questions:

   a. Describe three common ways of grouping plants.

      (1)

      (2)

      (3)

   b. Discuss briefly the plant division spermatophyte.

   c. Discuss the subphylum angiosperm.

   d. Discuss the difference between a monocotyledon and a dicotyledon.

   e. Discuss the binominal system used in classifying plants.

4. List six monocotyledon and six dicotyledon crops.

   (1) (1)
   (2) (2)
   (3) (3)
   (4) (4)
   (5) (5)
   (6) (6)

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SELECTION OF PLANTS–FIELD CROPS

Most staple field crops produced today were introduced into the U. S. from other parts of the world. When the early settlers came to this country they brought varieties of plant seed and plants to assist in supplying their basic foods and a few fibers. The crop selection process has been in operation since the introduction of these first plants. In 1889, a division of the U. S. Department of Agriculture, the Bureau of Plant Industry, was given the responsibility to introduce imported crop varieties.

Crop improvement actually began with the primitive individual. Many tribes and races of people have lived on one type of grain and nongrain crop for hundreds of years. For example, the Aztec, Mayan, and Inca Indians of Mexico and Central and South America were dependent upon corn as a basic cereal crop.

Most crops are native of countries other than the U. S. A crop that is known to be a native of this country is beans. Figure No. 1 gives the home country of several major and minor crops of which the majority are successfully produced in the U. S.

World Contributions to Crop
Production of the United States

Crop	Home Country or Countries
Cotton	-Mexico and Asia
Corn	-Mexico, Central and South America
Tobacco, tomatoes, and peanuts	-South America
Rice, alfalfa, and soybeans	-Asia (Rice - India) (Soybeans - China)
Field peas, oats, clover, and vetch	-Europe
Wheat	-Asia Minor (Turkey, Saudi Arabia)
Barley	-Asia and Ethiopia
Beans	-United States
Potatoes	-South America
Sorghums	-Africa
Citrus fruit	-Asia

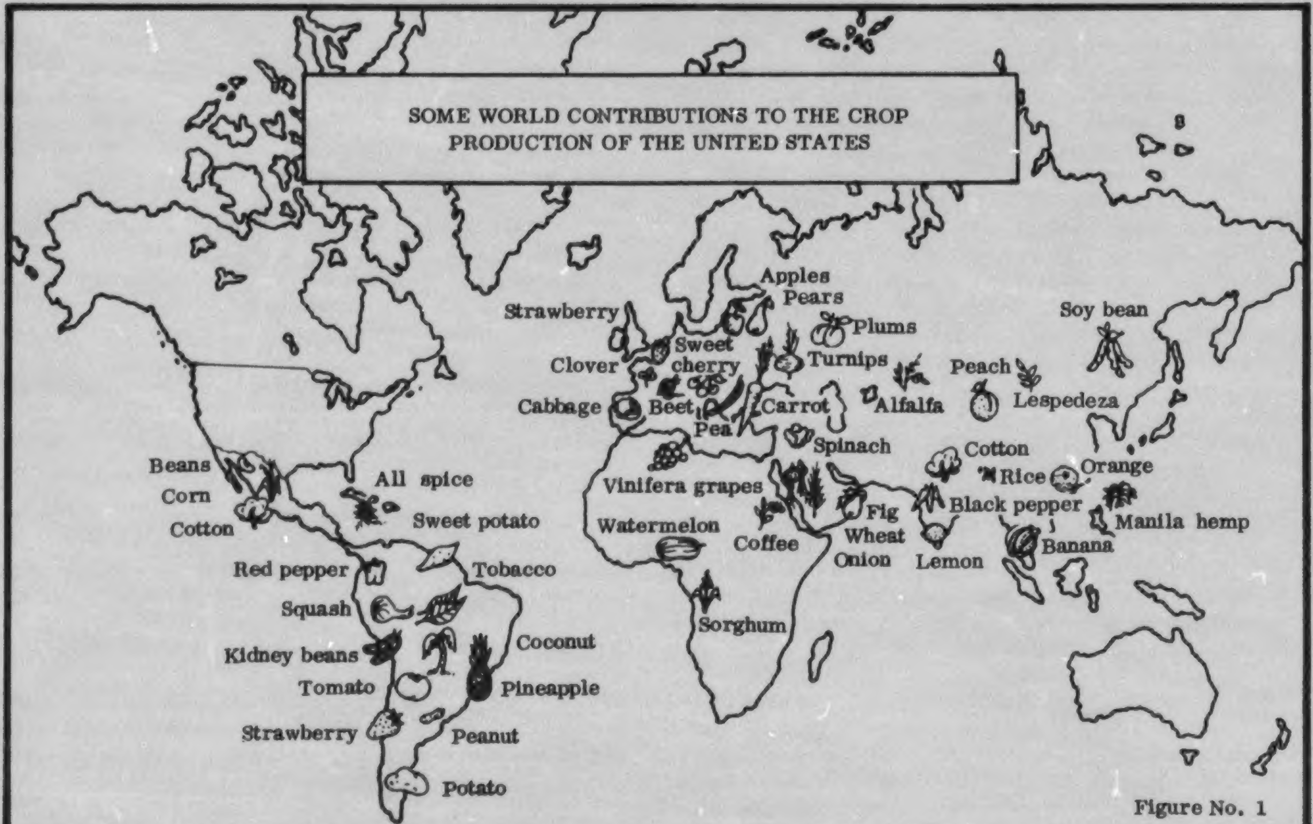
SOME WORLD CONTRIBUTIONS TO THE CROP PRODUCTION OF THE UNITED STATES
Apples
Pears
Strawberry
Plums
Soy bean
Sweet cherry
Turnips
Clover
Peach
Lespedeza
Cabbage
Beet
Carrot
Alfalfa
Pea
Spinach
Cotton
Rice
Orange
Beans
Corn
Cotton
All spice
Vinifera grapes
Black pepper
Manila hemp
Sweet potato
Watermelon
Fig
Wheat
Coffee
Banana
Onion
Lemon
Red pepper
Tobacco
Squash
Sorghum
Kidney beans
Coconut
Tomato
Pineapple
Strawberry
Peanut
Potato

Figure No. 1

Crop Selection Methods Used by Early Agriculturists

The earliest agriculturists selected different types and strains of crops according to need, general use, and the crop's ability to adapt to various soils and climatic conditions. For example, the American Indian selected and stored seed corn each year. Corn grown by North American Indians at the beginning of the sixteenth century compared in quality to corn grown by the American settlers about 1850.

Farmers of the New World withheld a portion of the seed after harvest for the following season's planting. In some cases cotton, peas, and sorghum seed were selected from plants that were favored with a good environment. Corn was selected according to the size of ear and fullness of grain.

In most cases no field selection was made. Planting seed was selected from the storage bin. Seed that appeared normal in shape and free of insect damage and disease were selected for planting seed.

Factors Affecting the Choice of Crops

There are many factors that affect the type or types of crops grown in a locality. Some of these factors are:

Crop Use and Market - Is the crop or a portion of the crop to be used as food or feed at home? Is there a market for the crop? There must be a need for the crop being produced. For example, vegetables must be produced near processing and packing plants and wholesale markets.

Climate - Is the crop adapted to the local climatic conditions? How will the temperature, rainfall, humidity, and wind affect the crop? Some varieties produce more than others in some areas where climate is a production factor. A freeze causes some plants to be more productive.

Soil - What type of soil is best suited for the crop? Does the crop require a clay, sand, or silt soil? Is the crop adaptable to an acid or alkaline soil? Can the crop be grown best on a shallow soil or a deep soil? It is recognized that soil is one of the most important factors in choosing a crop. Does the soil respond to fertilizers? The type of soil is a major factor in determining the type of crop.

Labor, Machinery, and Equipment - Are labor and equipment available to produce and harvest the crop? Hired hand labor and available custom equipment may affect the decision on choosing a crop.

Available Acreage - Can the proper amount of land be procured to justify the crop? Small grain production will require a large acreage, whereas vegetable production may require a small acreage.

Insects and Diseases - What control practices are necessary to grow the crop? Is the crop resistant to certain insects and/or diseases? For example, Acala cotton 1517 WR is resistant to verticillium wilt (a disease caused by a fungus that attacks the plant root). Research is working on the development of a cotton-plant with pigments that will be resistant to the boll worm.

Maturity - If the crop is a cool weather plant, will it mature and produce fruit during hot summer months? If it is a warm weather annual, will it reach maturity before the average frost date in the fall? For example, certain cotton varieties may mature in 95 days, whereas other varieties require 120 days to mature.

Quality of Product - The market is based upon the quality of raw materials. Crops are sold according to quality. Why shouldn't the producers select a variety that has quality? For example, if both Lone Star and Acala cotton varieties are adapted to the locality, yet Acala produces 1/8 inch longer fiber, which variety should be selected? Long staple cotton brings a better price than short staple cotton.

Size of Plant and Yield - The producer's net income is based upon two factors; quality and quantity. Yield varies with variety; therefore, the producer selects a crop that is a high producer. If Martin's Milo has an average production of 3500 pounds per acre and Plainsman 4000 pounds per acre in the same county, why will the producer select Plainsman? If the conditions are the same, both varieties will bring the same price per 100 pounds on the market.

Cost of Production - What net income could be expected from the crop? What phase of production (planting, cultivating, controlling insects and/or diseases and harvesting) is most expensive? The most expensive phase should be studied to reduce expenses.

Selecting Methods

The term "selection" may have a different meaning as used by the producer in comparison to its use by the plant breeder. Usually the producer selects crops on the basis of market value at harvest time, whereas the plant breeder selects on the basis of improving the crop. Some of the reasons why a plant breeder uses crop selection methods are:

Develop plants to produce both quantity and quality fruit.
Develop plants that are both insect and disease resistant.
Develop plants that can withstand certain temperatures and different levels of moisture.
Develop plants that produce fruit during a short growing season.
Develop plants that can be harvested with special equipment and machines.
Develop plants to produce fruit that can be transported with minimum spoilage.
Develop plants that are adaptable to certain soil types.
Develop plants that produce seed for good germination and growth.
Develop plants that are free of lodging (weak stem plants).
Develop new varieties of plants from existing varieties.

The two most important plant selection methods are:

Mass Selection. Mass selection consists of selecting plants with desired characteristics. The seed of these plants are mixed and planted together, then another selection is made which eliminates the weaker or undesirable ones.

Grimm alfalfa, Tennessee Winter barley, and Reid's yellow dent corn are examples of mass selection of field crops. Grimm alfalfa and Tennessee Winter barley were developed through mass selection for winter hardness.

Open-pollinated corn was selected in the fields and corn cribs for many years. The result of the mass selection method was more uniformity in ears and seed and the filling of tips and butts of ears.

Pedigree Selection. Pedigree selection is referred to as pure line and individual selection. Individual plants are selected and their performance is recorded on a record.

Seed for the individual plant is planted in an individual plant row. Self-fertilization and cross-fertilization can be used in this method.

Performance records can plot characteristics such as growth, yield, fruit quality, disease and insect resistance, and lodging. In each selection the best plants are chosen for seed producers.

Types or Groups of Plants Selected According to Use

Field crops are also classified according to groups or types. The group or type is determined mainly by the characteristics of the fruit and the general characteristics of the plant. For example, dent corn comprises 95 percent of all corn grown in the United States. It is partially identified by the shrinking of soft starch found in the crown end of the kernel as it ripens. The grain has a very starchy endosperm (the starchy part of the seed). The selection according to type depends largely upon the utility value or need for the whole plant, its fruit, or both plant and fruit. Some common types of crops are:

Types of Corn

Dent corn is grown for livestock feed and human cereals.
Sweet corn is usually harvested as human food before maturity. When mature, the kernels are very wrinkled.
Flour corn or soft corn has an endosperm composed of soft starch. The kernels are smooth. It is one of the most popular corns among American Indian tribes.
Popcorn is identified by a small ear containing a hard flinty type of starch in the small kernel. It is used for human consumption.
Flint corn kernels are composed of a hard starch. It is usually resistant to the weevil, it makes good corn meal, and it is good livestock feed when the kernels are ground.
Pod corn is not considered of commercial importance in the United States. It is believed to be a primitive plant.

Types of Sorghums

Grain sorghums are used for grain, hay, and silage.
Forage sorghums are used for silage, hay, and pasture.
Sugar and syrup type sorghums are used for hay, silage, pasture, and syrup.
Dual-purpose sorghums -- grain and forage types are used for grain, hay, silage, and pasture.

Types of Wheat

Common wheat is used to make flour. About 95 percent of all wheat grown in the United States is of the common type.
Duram wheat is considered to have the hardest grain of all wheats. It is resistant to drought and black stem rust. This wheat is not suitable for bread flour, but it is used for macaroni and spaghetti.
Club wheat is of minor importance in the United States. It is used for making pastry flour and for exporting purposes.
Poulard, Einkorn, Emmer, Polish, and Spelt wheat types are not grown extensively in the United States.

Types of Barley

Six-row barley is the most common barley grown in the United States. This barley is used for making malt and feed.
Two-row barley is not an important barley in the United States. It is preferred in Europe for malting purposes. Two-row and six-row refer to the number of rows of grain on the head of barley.

Types of Oats

Common oats are grown for feed and pasture. White oats are the most common in this group. Cultivated red oats are also an important grain and pasture plant, but they are grown only in the south.

Types of Rice

Short-grain rice is grown in California, and it consists of Japanese varieties.
Medium-grain rice is grown in Louisiana and Arkansas.
Long-grain rice is also grown in Texas, Louisiana, and Arkansas.
All types of rice are used for food. In most areas rice is selected according to maturity time, production, lodging, and demand or market. Long-grain may have a higher grain-breaking percent when milled than the other two types.

Types of Cotton

Upland cotton varieties comprise most of the annual cotton crop in the United States. The staple range is from short to long (3/4 to 1 1/2 inches).
Sea Island and American-Egyptian (Pima) cotton is grown mostly in three states. Sea Island is found in Georgia and Florida, and American-Egyptian is found in Arizona.

Some Common Varieties and Hybrids of Corn, Sorghum, Wheat, Barley, Oats, Rice, Cotton, and Soybeans Grown in Texas

There are over 1,000 varieties of corn grown in the United States. Open-pollinated varieties include:

Surcropper (white)
Ferguson Yellow dent
Mexican June
Hastings and Thompson Prolific
Country Gentleman, Crosby, Stowell's Evergreen, and Honey June (sweet corns).
White Rice, Jap Hulless, and Supergold (popcorn).

Corn Hybrids

Texas 28, 30, 34, 36, and 17 W.
Purdue 39, Purdue 51, Purgold, and Carmel cross (sweet corns).
Purdue 31, K4, and Purdue 38 (popcorn).

Sorghums

Grain Sorghum

Milo - Sooner, Double Dwarf, Caprock, Martin's, Plainsman, and Redbine.

Kafir - Blackhull, Red, Dwarf, Combine, and Dafir 60.

Feterita - Standard, Spur, and Dwarf.

Hybrid - Texas 660, Texas 601, Texas 611, Texas 620, DeKalb C44a, and RS 590.

Durra (Egyptian corn) - White, Brown, and Dwarf.

Sweet Sorghum (Sorgo)

Regular - Sumac, Honey, Atlas, and Black Amber.

Hybrids - Beef Builder and Silage King.

Grass Sorghums

Piper Sudan, Wheeler Sudan, and Sweet Sudan S. A., 372.

Wheat - Blackhull, Tascosa, Milam, Ponca, Bison, Concho, Crockett, and Quanah.

Barley - Wintex, Kearney, Reno, Texan, Rodgers, Goliad, Tunis, Harlume, and Ward.

Oats - New Nortex, Alamo-X, Bronco, Radar-I, Victorigrain, Cimarron, Wintok, Mustang, Moregrain, and Suregrain, Ferguson 922, Frazier, Coronado, Cortez, Houston, Ora, and Norwin.

Rice - The rice varieties are:

Short-grain varieties - Caloro and Asahi.

Medium-grain varieties - Magnolia, Zenith, Nova, Nato, Saturn, and Gulfrose.

Long-grain varieties - Bluebonnet 50, Sunbonnet, Bluebelle, Texas Patna, Belle Patna, Improved Bluebonnet, Toro, TP49, Starbonnet, Rexoro, and Century Panta 231.

Cotton - In 1910, there were 613 varieties of cotton listed in Tyler's report. At the present time there are about 40 varieties planted. Immediately after World War II about 50 percent of the cotton acreage in the United States was devoted to the strains (plants derived from varieties) from the six following varieties:

Mebane, Acala, Stoneville 2B, Coker 100, Half and Half, and Deltapine.

The following information is a list of Texas cotton varieties with a number of strains developed from the variety:

Half and Half - Hibred and Stormproof.

Lone Star - Lankart Sel. 57, Northern Star 4-11, and Wacona.

Mebane - Qualla, Watson, Texas Special, Mebane 141, Bagley, Western Stormproof, and Lockett 140.

Rowden - Rowden 40, 41A, 41B, and Malone's Rowden.

Paymaster - Paymaster 54-B and Paymaster 101.

Acala - Acala 1517, 4-42, 1517BR, Texacala 5455C, California Acala, and Rodger's.

Deltapine - Deltapine 14 and 15.

Stoneville - Stoneville 7 and 3202.

Sea Island - Seabrook and Seaberry SXP-30.

American Egyptian - Pima, SI, Supima, and Earlipima.

Stormresistant - Blightmaster, Stormmaster, Stormking, Stormproof No. 1, and Stormrider.

Other Varieties and Strains - Coker 100, Austin, Rex, Delfos 9169, Tamcot, and Dunn 56C.

Soybeans - Hill, Wayne, Patterson, Clark 63, Lee, Bragg, Hood, Semmes, Davis, Hampton, Dare, and Bossier.

Usually seed and plant suppliers purchase varieties that are adaptable to their particular area or locality. There are many sources of information that recommend the proper variety for the locality. Usually this type of information is available through the producer (farmer) in the area.

NOTES

SUGGESTED STUDENT ACTIVITIES

1. Match the appropriate country with the crop (world crop contributions) by placing the correct number in the parentheses.

   a. Sorghums ( )
   b. Rice ( )
   c. Soybeans ( )
   d. Cotton ( )
   e. Wheat ( )
   f. Beans ( )
   g. Potatoes ( )
   h. Citrus fruit ( )
   i. Corn ( )
   j. Peas ( )

   (1) India
   (2) Asia Minor
   (3) United States
   (4) Africa
   (5) Asia
   (6) Mexico and Asia
   (7) Mexico, Central and South America
   (8) Europe
   (9) South America
   (10) China

2. Discuss the following questions:

   a. What are at least three reasons the earliest agriculturists selected different types and strains of crops?

      (1)

      (2)

      (3)

   b. What method did the early agriculturists use to select seed?

   c. What is the difference between mass selection of plants and pedigree selection?

   d. What government agency was given the responsibility to introduce crop varieties through importation?

   e. Why does the term "selection" have a different meaning to the producer than to the plant breeder?

3. List and briefly explain the factors that affect the type of crops grown in a locality.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

   i.

   j.

4. Briefly discuss the following types of crops:

   a. Dent corn -

   b. Grain sorghums -

   c. Common wheat -

   d. Two-row barley -

   e. Common oats -

   f. Long-grain rice -

   g. Upland cotton -

NOTES

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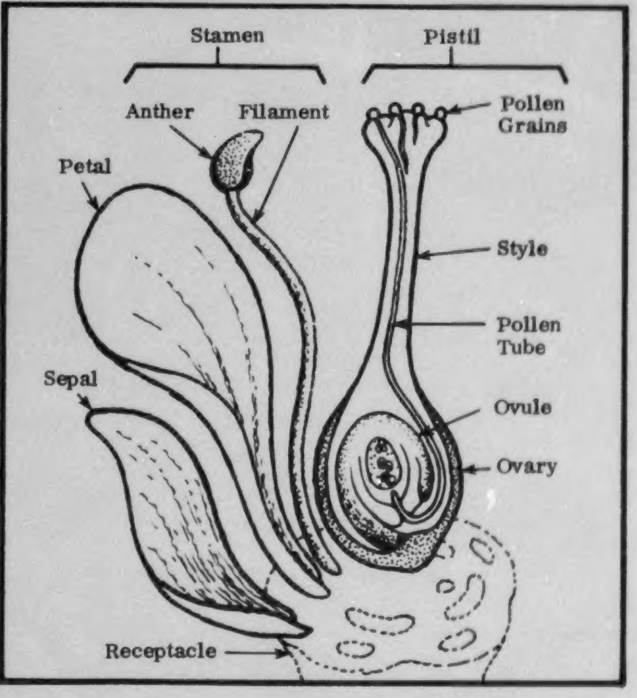
SEXUAL AND ASEXUAL REPRODUCTION

Most field crops are produced from seed; therefore, it is important that agriculturalists learn as much as possible about seed production. Seed crops are very important in the entire world as a basic food for man's diet, a basic feed for the animal's ration, and reproducing seed for plant propagation. Seed can be transported and stored more easily than most food and feed raw products.

Plants possess similar heredity characteristics as animals; that is, they reproduce their own kind with possible variations in conformation, color, and size. The primary functions of the flower and seed are to reproduce the parent plant. A flower exists to produce fruit, and fruit contains seed.

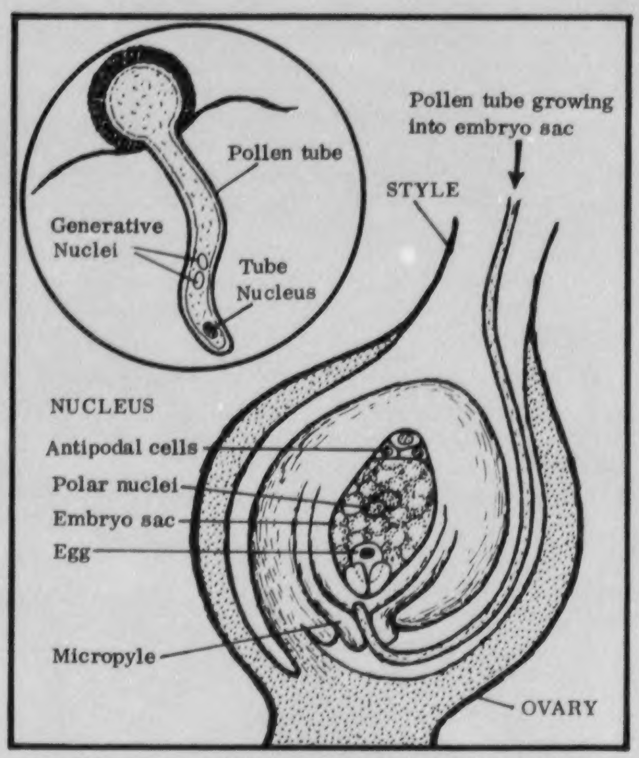
Essential Reproductive Parts of A Flowering Plant


Stamen
Pistil
Anther
Filament
Pollen Grains
Petal
Style
Pollen Tube
Sepal
Ovule
Ovary
Receptacle

1. Pistil - The female part of the flower within which egg cells originate. This part consists of the stigma, style, and ovary.

   a. Stigma - The uppermost part of the pistil upon which pollen falls from the anther and is held. When pollen is transferred from the anther to the stigma the common term used is pollination.

   b. Style - The part of the pistil that supports the stigma and the place where pollen grains germinate and grow from the top of the stigma to the ovary cavity.


Pollen tube growing into embryo sac
Pollen tube
STYLE
Generative Nuclei
Tube Nucleus
NUCLEUS
Antipodal cells
Polar nuclei
Embryo sac
Egg
Micropyle
OVARY

   c. The ovary is the lower part of the pistil that produces the ovules which develop into a seed or seeds. The ovule is the structure containing the embryo sac in which the seed is formed after fertilization takes place. The zygote is formed when the generative nuclei unite with the egg nucleus. Fertilization takes place after the pollen tube passes through the micropyle or opening to the ovule.

2. Stamen - The male part of the flower consists of two main parts, the filament and anther. The stamen is the flower part that produces the pollen.

   a. Filament - This part of the flower is the stalk of the stamen that supports the anther.

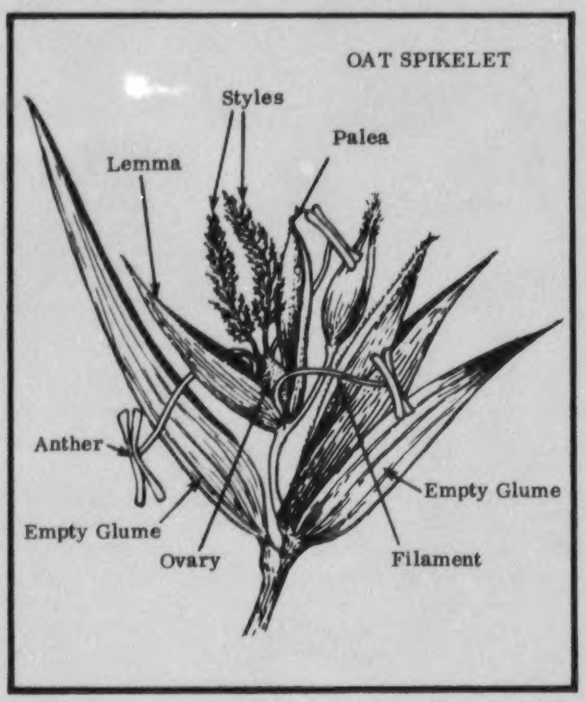
   b. Anther - The anther is the pollen bearing part of the stamen. Pollen is dust-like spores that contain the male germ cells of the plant. They are reproduced within the anther.

3. Accessory Organs - These parts serve to protect the essential organs and to attract insects. These organs were briefly discussed in IV-B-1, Plant Structure - Functions of Plant Parts. Further discussion is as follows:

a. Corolla - The petals of a flower in a group together are known as the corolla which is usually in the form of modified leaves of a delicate texture and of various colors, depending upon the species of plant. The petals enclose the pistil inside the calyx. Due to color, odor, and nectar secretion, the petals attract insects.

b. Calyx - This part of the flower is all the sepals grouped together. It is a circle of leaf-like parts located below the petals or corolla. The cup-like structure supports and protects the flower during its early stages of development and after the flower has matured.

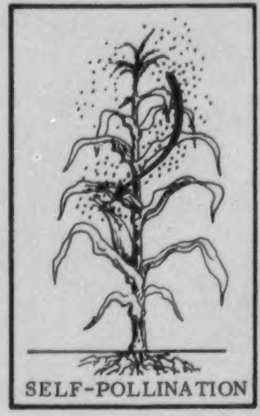
c. Receptacle - The floral parts are borne upon the terminal portion of the pedicel or peduncle. This part may be known as the enlarged end of the stalk which supports the entire flower.

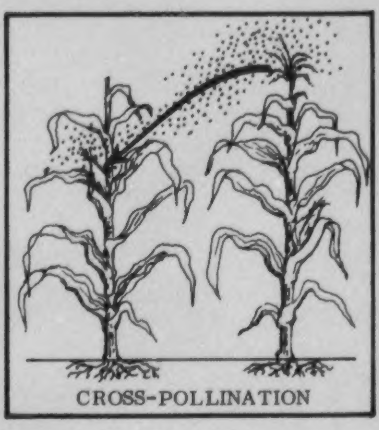


In some angiosperms the petals and sepals are missing. In others only the petals are missing. Small grains such as oats and monocot or grass plant flowers are incomplete because they lack one or more parts of the floral structures. Small grains lack petals and sepals. However, these plants are referred to as perfect flowers because both the stamen and pistil are present in the same flower. A corn plant is an example of an imperfect flower. The stamen is borne in the tassel and the pistil on the ear. An oat spikelet will bear several flowers, whereas a barley spikelet bears only one flower. At the bottom or base of small grain or grass inflorescences are located sterile glumes (bracts or modified leaves) and above the glumes are the lemma (lower bract enclosing the flower and palea) and the palea (upper bract enclosing flower). The flower of the grass plant is borne within the pair of bracts (lemma and palea). Most grass plants have three stamens and two styles. The styles appear feathery.

The Pollination and Fertilization Process of Sexual Reproduction

The end product of sexual reproduction in plants is the seed. The first process that takes place in seed formation is pollination. Pollen is produced in the anthers. As the anthers split open, the pollen grains are transferred to the stigma. Flowers are self-pollinated when the pollen is transferred from the anther to the stigma within the same flower or a flower on the same plant (corn). Flowers are cross-pollinated when the pollen from the anther of a flower of one plant is transferred to the stigma of a flower on another plant. Alfalfa and many of the clovers are dependent upon cross-pollination. Bees and many other insects that obtain nectar from flowers collect pollen on their bodies and transfer this pollen to other plants. Many of the perennial grasses and corn are cross-pollinated by wind blowing the pollen to the flowers of different plants (grasses).

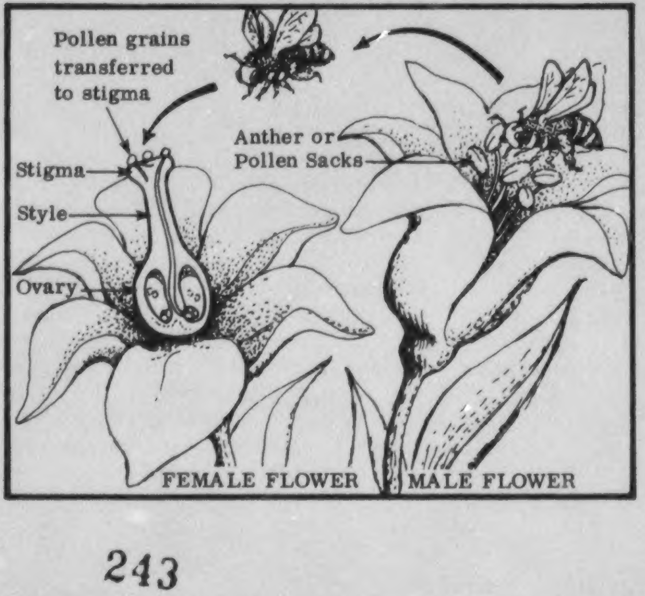




Bees Pollinating Imperfect Flowers

There are other ways that pollen grains are distributed and transferred to stigmas of plants. In self-pollination, gravity, wind, and insects are the major ways of pollinating flowers. Cross-pollination is accomplished by wind, insects, large animals, and even hummingbirds.

The second process that takes place in seed formation is fertilization. Steps involved in fertilization (the pollen nuclei or sperm uniting with the ovule nuclei and egg) are as follows:



1. The pollen is anchored on the moist and sticky stigma.

2. The pollen grain germinates, producing a pollen tube which grows down through the style (page 1) and into the ovary where it reaches the ovule and embryo sac. At this point of growth it releases two sperms in the tube.

3. One sperm unites with the egg cell forming the zygote (a cell formed from the fusion of male and female gametes) which forms the embryo plant by cell division.

4. The second sperm unites with two separate nuclei to form a primary endosperm nucleus. Steps 3 and 4 are called double fertilization.

An example of pollination and fertilization in a monoecious plant (corn) is as follows:

Pollen from the male flowers on the tassel are transferred to the pistillate flower (silk) of the same and other plants.

The pollen grain germinates, sending a pollen tube through the style or silk to the ovules, or blisters, on the young cob. Each blister is an ovary (later a grain) which contains a single ovule.

The sperm cell unites with the egg cell in the embryo sac, forming the embryo. The other sperm cell unites with two other cells, forming the endosperm or plant food for the young plant to use until photosynthesis takes place. The embryo and endosperm develop within the same seed coat, and the mature grain contains both endosperm and embryo. In the bean, the embryo absorbs the endosperm; therefore, it is transferred to the cotyledons.

Reproduction, or the production of fruit and seed, cannot take place unless there is a successful union of the sperm and egg; that is, the egg cell (female) must be fertilized. After fertilization takes place in the ovary, the ovule or seed begins to develop. The egg cell remains in the embryo sac of the pistil during the process of fertilization.

General information about the corn plant includes:

As many as 15,000,000 pollen grains may be furnished by flowers on one tassel.
Pollen may not remain viable much longer than one day after leaving the tassel.
After the pollen reaches the stigma, fertilization begins in about one day (24 hours).
Only one pollen grain is needed for the development of each corn kernel.
It is estimated that about 5 percent of the kernels are fertilized by self-pollination, and the remaining 95 percent are fertilized by cross-pollination.
The pistillate (silk) or female flowers number approximately 800 per plant.

Asexual Reproduction—A Method of Producing Crop Plants

Asexual reproduction is without sexual action; it does not involve the fusion or uniting of the sperm and ovum. It eliminates the dependence upon flower pollination and fertilization that is necessary in sexual reproduction.

Asexual reproduction is called vegetative reproduction or propagation, because a part of the plant is used instead of seed for propagation. The vegetative parts of many plants have the capacity to reproduce new roots and new shoots as found in cuttage and layerage. Plant parts also unite by forming a vascular connection or cambium union as found in budding and grafting.

1. The Importance of Vegetative Reproduction

   a. The cutting from a parent plant will have the same genetic make-up as the parent plant. In many seed-bearing plants, seedlings are different from the parent plants in quality when produced directly from the seed. A pecan seedling grown from the seed will produce fruit but it may not possess the desired characteristics for the variety; the fruit may be inferior in quality. This condition usually exists when the parent plant is a hybrid.

   b. Sugarcane, seedless grapes, navel oranges, bananas, and certain sterile hybrid plants do not produce viable seed; therefore, it is necessary to propagate such varieties by vegetative propagation. Such plants could be lost entirely if the present parent plant died and there was no vegetative method to propagate them.

   c. The dormancy period required by some plants that produce seed can be eliminated if the plant is produced asexually.

   d. Selection for desired characteristics is more reliable in asexual than sexual reproduction. Propagation of plants asexually gives identical characteristics from parent to off-spring. Selection of mutations (changes) in vegetative reproduction have improved many varieties of plants. As an example, sweet potato improvement has been made by the proper selection of plant mutations. The sweet potato is a close relative of the morning glory. The non-flowering type of sweet potato has been induced to flower by grafting it with the morning glory. Some mutations in tubers (potatoes) have been developed to increase both the quantity and quality.

2. Definitions of Means of Plant Propagation

   a. Belowground propagation

      (1) Roots - Subterranean (belowground) parts of the plant without nodes. Plant examples are: sweet potato and cassava.

      (2) Tubers - Short thickened parts (stem) of a plant with buds and eyes that grow belowground. Examples include: Irish potatoes and artichoke.

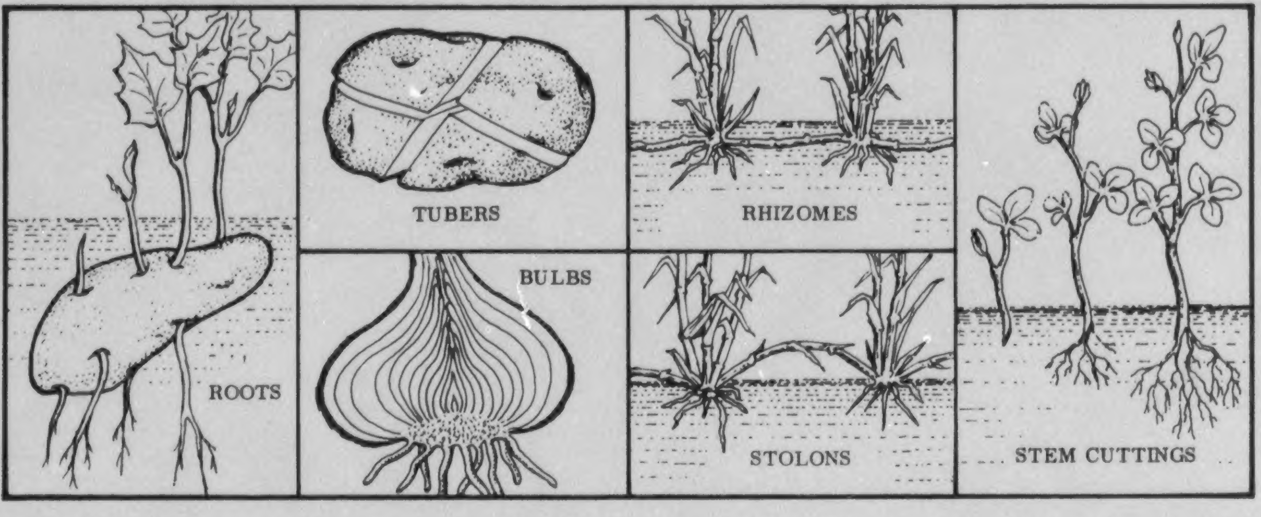
      (3) Rhizomes - Plant stems, horizontal belowground; usually sending up a plant and sending down roots

at the nodes. Examples are: Johnson grass, bermuda grass and asparagus.

(4) Bulbs - Usually grown underground and known as a stem. It has scale-like fleshy leaves. Examples include: onions, garlic, and tulip.

(5) Stolons - Plant stems aboveground (runners) but placed belowground so roots will form at nodes producing new plants. Examples are: Bermuda grass and buffalo grass.

(6) Stem Cuttings - Portion of plant, usually with nodes or eyes (buds), placed in the soil for the purpose of producing a new plant. Examples include: sugarcane, sweet potato, clover, alfalfa, lespedeza, and sugar beets.



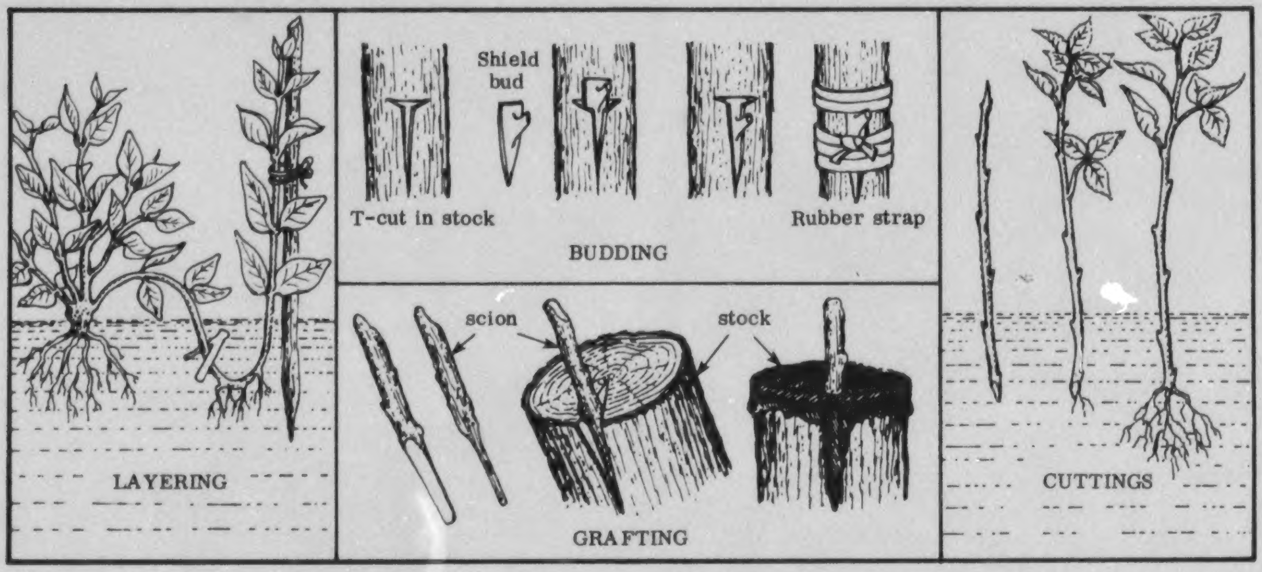
b. Aboveground propagation

(1) Layering - New plants propagated from the stems while still attached to the parent plant. The stems root and send up shoots where they are covered with soil. Many species of plants can be propagated by this method.

(2) Cuttings - Part of the plant: root, stem, leaf, or leaf bud placed in a rooting medium for propagation. Root and stem cutting is a common plant propagation practice in the fruit industry.

(3) Budding - A single bud (a rudimentary stem or branch) is inserted into an incision beneath the bark of a stock. This is a very important method of asexual reproduction.

(4) Grafting - The joining together of one plant part with another so that the cambium layers (living cells between the outer woodsap and inner bark) of the scion (the twig inserted into the stock) will be in contact with each other. Grafting is equally as important as budding.



3. Vegetative Propagation of Plants by Layering, Cuttings, Budding, and Grafting

   a. Layering may be done by covering a part of the stem with soil, or by an air-layering process. The latter process is accomplished by making an incision on the stem and wrapping it with a moisture-holding moss and then polyethylene. After roots develop, the stem is cut and planted. Air-layering is performed on branches in shrubs, trees, and vines. Many species of berries are propagated by some form of layerage.

   b. Cuttings of root, stem, leaf, and modified stems (tubers and rhizomes) is one of the most common means of vegetative plant propagation.

A description of the four main classes of cuttings is as follows:

Usually, if plants produce root suckers they may be propagated by root cuttings. Fruit, such as pecan, apple, pear, and blackberries may be propagated by cuttings. Sweet potato and horse-radish are also propagated by this method. The roots of these plants are cut in 2 to 3 inch sections and are placed in a rooting medium.

Leaf cuttings from the orange and lemon will produce plants if a small portion of the petiole is attached. This method is used more in tropical plant propagation and to produce ornamentals in the greenhouse.

One of the most successful methods used for sweet potato production is by stem cutting propagation. The propagation of grapes, citrus plants, roses, and figs is mainly through this method. A portion of the stem is inserted in a rooting medium (soil).

Cuttings of modified stems are a very important method for propagating certain grasses, white potatoes, and cassava. The cuttings should have an eye or thickened area for sending down roots and growing shoots.

   c. Budding, a form of graftage, is one of the most popular and successful methods used to propagate many fruit and nut trees and roses. It is one of the most common ways to propagate new trees. Budding provides a way to charge varieties on new plants. The two types of buds are normal (buds developed normally on the plant at a leaf base or terminally on the stem) and adventitious (buds developed in positions other than where normal buds are found).

   d. Grafting is one of the oldest methods of asexual reproduction. It was practiced before the birth of Christ. Scions may be grafted on like or unlike stocks. An example of the former is the grafting of papershell pecans on a wild pecan seedling. The grafting of a plum to a peach rootstock is an example of the latter method where scion and stock are unlike each other.

   Some of the different kinds of grafts are: whip, inlay side, cleft, bark, bridge, and inarch.

4. The Production of Forage Crops

Many forage crops are propagated either by stolons (runners) or by rhizomes (underground stems). Some plants reproduce vegetatively and by seed. The producer plants such crops the most convenient way. An example of this type of crop is the Irish potato. The producer or grower plants the tuber and the plant breeder plants the potato seed. There are many pasture grasses that reproduce by both the rhizomes and seeds.

Asexual reproduction in forage crops permits the following practices:

Propagate varieties of crops that do not produce an abundance of good seed.
Produce plants that maintain the characteristics of the parent plant.
Produce plants with well developed clones (a group of plants produced from a single plant by asexual reproduction).
The selection and propagation of superior plants from varieties that have been produced by sexual means.

Why Plants May Fail to Reproduce

1. Reproduction is not likely to occur if something interferes with either pollination or fertilization in the flower of the plant.

2. The following conditions may interfere with reproduction:

   a. Either a frost or freeze may kill the flower or its vital reproductive parts (pistil and/or stamen).

   b. Hard rains or hot and strong winds may remove the pollen from the flower and even destroy the stamen and pistils.

   c. Cold temperatures may reduce insect activity; therefore, plants requiring insect assistance for cross-pollination may be affected due to the lack of pollen. Harmful insects can destroy the stamen and pistil.

SUGGESTED STUDENT ACTIVITIES

1. Completion - Insert the correct word or words to make a complete statement.

   a. Pollen is anchored on the moist and sticky __________.
   b. __________ grow belowground. They are short thickened parts (stems) of a plant that reproduce from buds and eyes.
   c. __________ propagation may be done by covering part of the stem with soil.
   d. Many forage crops are propagated by __________ or by __________.
   e. A common way to propagate berry plants is by __________.
   f. Asexual reproduction is also known as __________ reproduction.
   g. __________ is formed when the generative nuclei unite with the egg nucleus.
   h. The __________ is the structure containing the embryo sac in which the seed is formed.
   i. The parts of the stamen are __________ and __________.
   j. Pollen grains must come in contact with the __________ if fertilization is to take place.

2. Complete the Following Questions

   a. List the female parts of a flower.
      (1)
      (2)
      (3)
      (4)
   b. List the male parts of a flower.
      (1)
      (2)
   c. Describe the following flower parts:
      (1) Corolla

      (2) Calyx

      (3) Receptacle

   d. Discuss the following terms:
      (1) Self-pollination

      (2) Cross-pollination

      (3) Propagation by cuttings

      (4) Propagation by layerage

      (5) Propagation by grafting

   e. List six ways to propagate plants by using the belowground method.
      (1)
      (2)
      (3)
      (4)
      (5)
      (6)

3. True and False Statements - Circle the T for true statements and the F for false statements.

T F a. The zygote is the same as the pollen grain.
T F b. Stolons are plant stems aboveground.
T F c. Budding, a form of grafting, is a common way to propagate fruit and nut trees.
T F d. An imperfect flower either lacks the male or female part.
T F e. All angiosperms are composed of stamen, pistil, sepal, and petals.
T F f. Many species of berries are propagated by layerage.
T F g. One of the most common means of asexual propagation is the use of cuttings.
T F h. An orange or lemon leaf with the petiole attached can be used to propagate plants.
T F i. Selection for desired characteristics is more reliable in asexual than sexual reproduction.
T F j. Small grain flowers lack petals and sepals.

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DISPOSING OF PLANT RESIDUE

Proper disposal of land residue is considered a good soil management practice. The harvesting of most field crops fails to properly remove old plant stubble, stalks, and leaves that may hinder cultural operation for future crop production. Not only may cultivated crop residue interfere with seedbed preparation and crop cultivation but large weed materials may also affect good management practices.

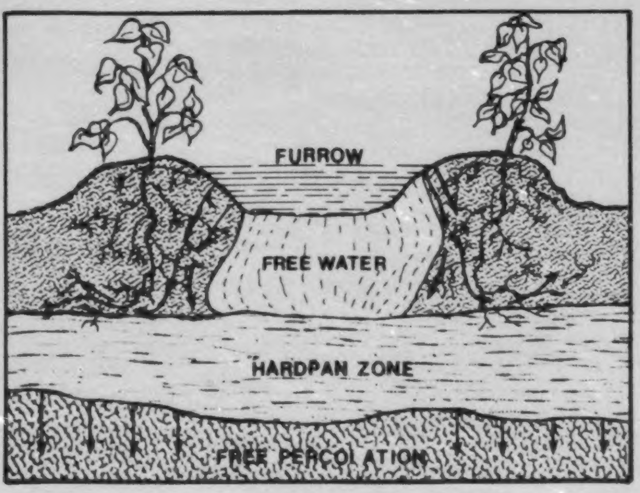
Crop residue is that part of the crop that remains on the soil after a part of it has been removed by harvest. The remaining part may be in the form of whole root systems, except for plants like potatoes. Plant residues can also be in the form of stubble, straw, leaves, stems, and manure. The decomposition of these plant parts furnishes the organic matter in the upper soil layer. As organic matter decomposes, minerals are made available to plant growth. The terms organic matter and humus are used interchangeably with residue. Actually, organic matter is partially decayed plant tissues that are nonrecognizable as they are returned to the soil. Humus is the end product of decomposed plant and animal residues or completely decayed organic matter.

The Importance of Disposing of Crop Residue

Crop residues and weeds increase the organic matter in the soil if the residue materials are properly mixed with the soil particles. This practice increases the amount of certain plant food elements due to the increase in organic matter.

Microorganism growth and action is improved by mixing crop residues and other plant materials with the soil. These residues serve as a lower animal life food.

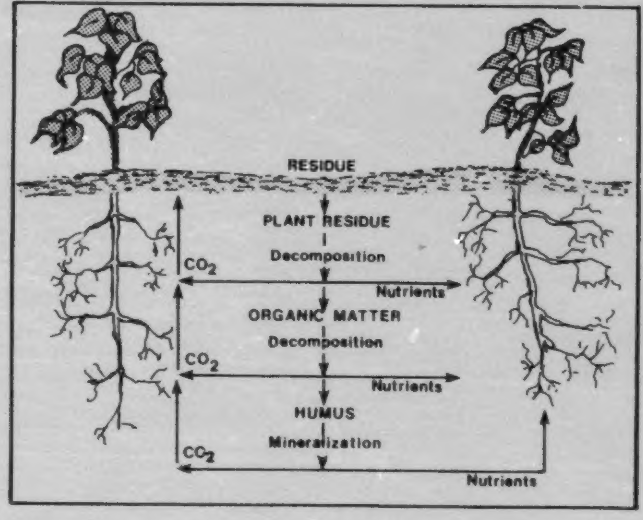
The mixing of fine crop plant trash with the soil tends to pulverize it, making a desirable soil condition.



Plant residue reduces the water runoff rate, thereby permitting a more desirable rate of percolation and permitting more evaporation of soil water from the top soil. It is possible that plant roots cannot penetrate the hardpan unless it is broken by a plow. Also, in most cases air circulation and temperature favorable to plant growth are maintained in a soil that contains adequate humus.

The insect population may be reduced by destroying aboveground winter hiding places. Many insects cannot live below the soil surface in certain stages of body development. Yet, there are many types of insects that must live in the soil during various stages of development. If the decomposition is rapid, it will help reduce the carry-over of viable disease-causing organisms.

Residue, Organic Matter, and Humus



The addition of crop residue to the soil is an important approved practice if other soil management practices are included in the soil building program. For example, a well managed soil, high in fertility, will furnish plant nutrients for microorganism growth and plant growth; soil low in nutrients will produce weak and inferior plants due to the microorganisms absorbing nutrients from the poor or infertile soil while feeding on the crop residues. Even though there are three stages of decomposition - plant residue ⟶ organic matter ⟶ humus, more than one stage may be taking place at the same time.

An important factor in plant residue decay is the carbon-nitrogen ratio in the soil and in plant materials. In the United States the average soil has a ratio of 11 pounds of carbon to 1 pound of nitrogen. Cottonstalks, cornstalks, mature grass, and plant straw have a carbon-nitrogen ratio from 60 or 80 to 1. The use of carbon and nitrogen as plant food elements is explained in the steps listed below:

As soon as plant residue is turned under the soil, bacteria actinomycetes, (rod-shaped bacteria) and fungi begin to feed upon it.

In most cases about 30 percent of the carbon is used as energy by the soil organisms in digesting the plant residues. The balance is given off as carbon dioxide. Only a small amount of humus is added to the soil in the process. If 2,000 pounds of straw residue is mixed in the soil only about 120 pounds of humus will be produced (that is, if no extra nitrogen is added).

Plant residues lack nitrogen; therefore, soil organisms use up the nitrogen immediately while they are building their own body tissue.

After the decay of plant residue is complete, many of the microorganisms die; plants feed on nitrogen released from the dead organisms.

Organisms compete with the plants for available soil nitrogen which may affect the rate of decay and rate of growth of crop plants.

The carbon-nitrogen ratio can be narrowed or reduced by applying nitrogen fertilizer to the residues. Other advantages of applying nitrogen fertilizers are:

More humus is added to the soil.
The rate of organic matter decay is increased.
Nitrogen is provided for both the microorganism and the plant.

Humus is considered the storehouse for soil base elements (potassium, calcium, and magnesium). It holds base elements in sandy soils, and it will hold four times the amount of bases as clay soils.

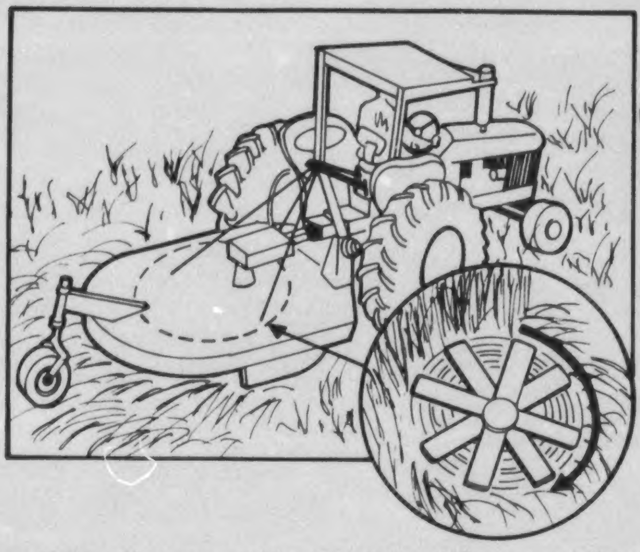
The carbon:nitrogen ratios of decomposition of various materials are as follows:

Humus	10:1
Legume residue	22:1
Non-legume residue	75:1

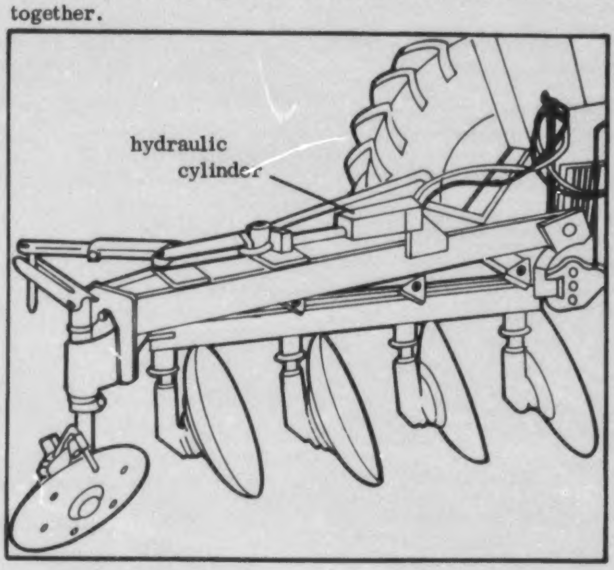
Decomposition is more rapid in leguminous plants than in non-leguminous plants due to the legumes being lower in carbon and higher in nitrogen. Organic materials should contain about 2 percent nitrogen for satisfactory decomposition. Nitrogen is taken from the soil by residue if it does not contain enough to decompose.

Practices Used in Disposing of Crop Residues

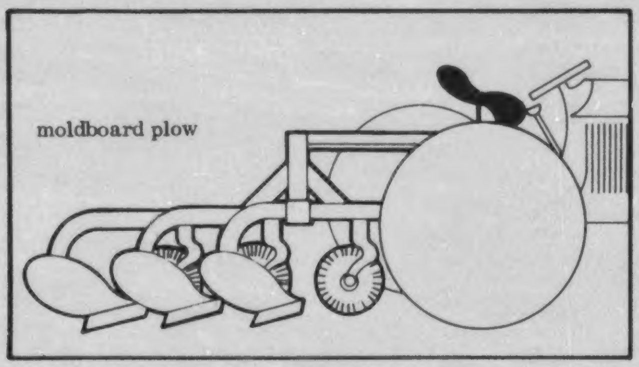
There are many methods and several different types of machinery used to destroy or process crop residue on the cultivated field. Some of the most common practices include using the following equipment:



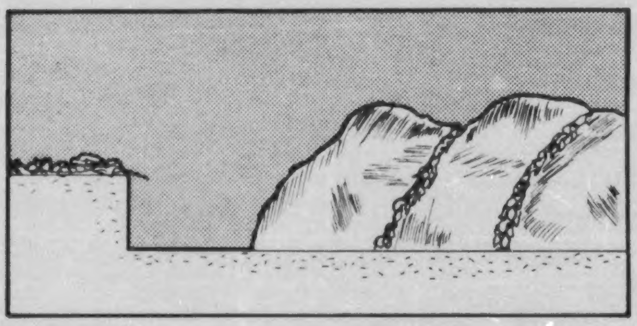
Rotary Chopper and Mower - Cottonstalks, cornstalks, sorghum stubble, weeds, and tall grasses are usually shredded with a rotary chopper or mower to make the soil more easily cultivated. It also increases the rate of decomposition of organic matter. Where pink bollworm infestation is a problem, the destruction of cottonstalks is required; therefore, they are usually shredded with a rotary chopper or mower. Five to 7 feet widths are commonly used except where two or more units are used together.

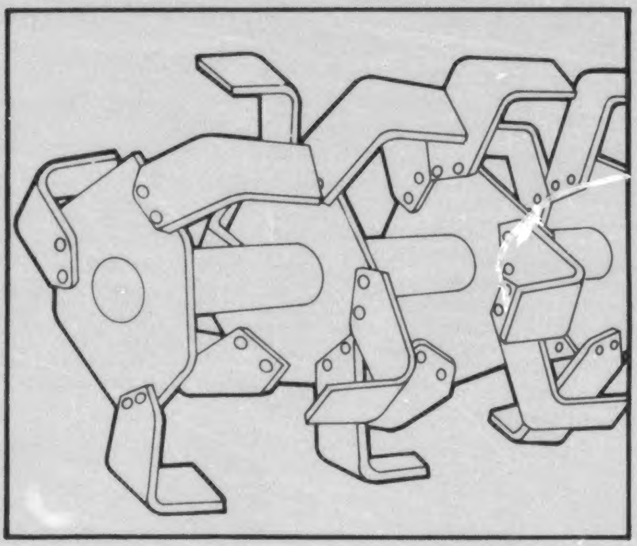


Disk Plows - The disk plow is similar to the moldboard plow except that it does create a suction; therefore, the disk must be set at the proper angle and the frame must be heavy enough (about 400 to 1200 pounds per disk) to keep the disk blade at the desired depth. Most of the residue is left on the surface when disk plows are used. The surface residue helps protect the soil against wind erosion in the western dry regions, and it helps hold the moisture from rain and snow. Disk plows vary in size. A standard plow may have from one to seven disks. Disk blades also vary in size, usually 24 to 38 inches.

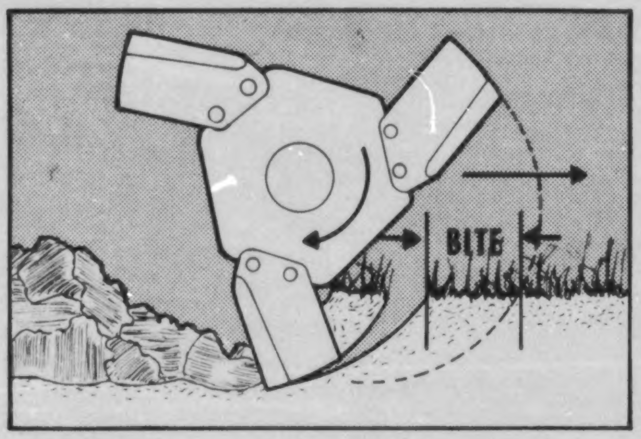


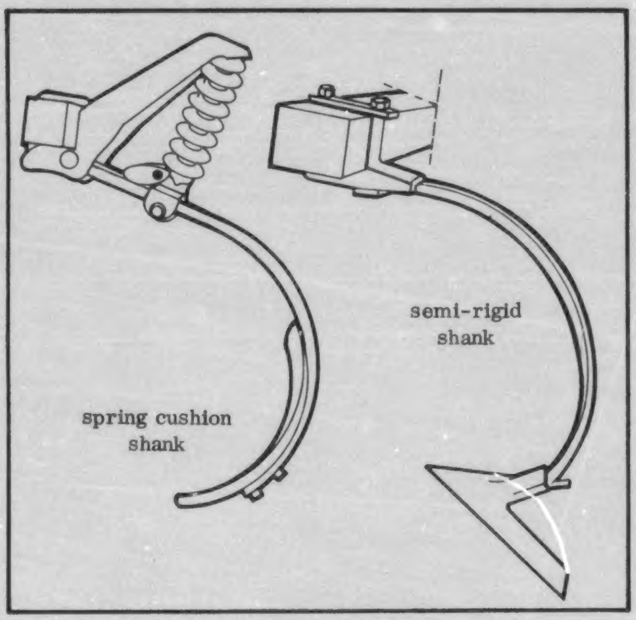
Moldboard Plows - Moldboard plows either single or double have a tendency to cover most of the crop residue. If the residue is covered between the slices, it serves as a wick for rain and snow. However, the soil surface is bare when plowed with a moldboard plow. The lister (single plow with moldboard on each side) is used to make rows or seedbeds. This type of plow is not shown in the illustrations. They form a trench or a bed (ridge) for planting. The moldboard plow is very popular in the Southern States.



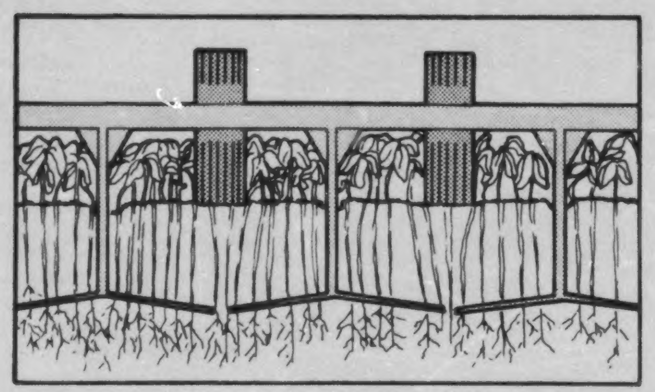


Rotary Tiller - The rotary tiller was first developed to use on small plots or acreage for garden purposes. This type of unit was a walk-behind self-propelled tiller. The larger tillers are tractor mounted or tractor drawn. The L-shaped blades are mounted on the tiller axle. They chop and mix the soil as the tiller moves forward. The main advantage of the tiller is that only one pass is required to chop crop stalks and mix them with the soil. However, trash is not covered as completely with the tiller as the moldboard plow. This type of plowing may destroy to a certain extent the soil aggregate.





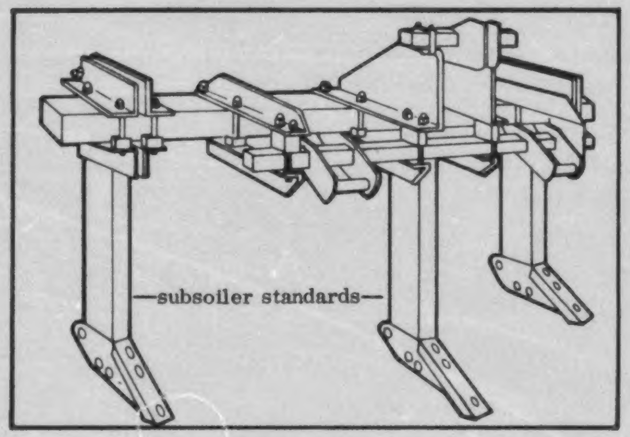
Chisel Plow - Chisel plows are used to break compact layers of soil or hard pans. In some areas chiseling is followed by disk harrowing to turn under crop residue and prepare a better seedbed. Two common types of shanks used on chisel plows are the spring cushion and the semi-rigid. Hydraulic reset shanks are also used where stumps, roots, and stones are a problem. The plow shanks may be equipped with sweep type or narrow chisel plow points. Like the disk harrow, chisels are used for stubble-mulching. This type of tillage is accomplished below the surface without removing all residues from the surface. Stubble mulching is used in small grain areas, especially where wheat, barley, rye, and oats are the main crops. Planting is performed through the mulch surface and cultivation is usually beneath the mulch in corn production. When sweeps are used they cut plant roots below the surface, which increases the amount of loose residue. The main reasons for stubble mulching are:



Water and wind erosion are reduced by leaving most of the crop residue as a cover on the soil surface.

Stubble mulching enables the soil to take in more moisture and reduce evaporation. It also aids in eliminating a soil top crust due to heavy rains and drying out of top moisture. The permeability (the rate water and air flow through the soil) of the top layer of soil is affected by the compactness and looseness of soil crust particles.

In dry land farming, yields are increased where crop residue is used to protect the soil surface. The soil will have a higher temperature in the early spring; therefore, seed germination may be more rapid.



Subsoiler - The subsoiler plow is used to loosen the layers of soil that cannot be reached by ordinary plows. It improves root penetration, soil drainage, and the infiltration of soil moisture. Effective subsoiling should meet the following conditions:

Subsoiling should be performed when the soil is dry enough to shatter. Wet soil will reseal after plowing.

The soil below the top compact area must have water holding capacity, and the soil must have the proper pH for root growth.

Tractor and heavy equipment wheels should not be run in the subsoil slots. In fact, it is considered a good practice to operate equipment wheels at least one foot away from the chisel slots.

If there is a deep layer of sand below the main root growing area, subsoiling should be performed above this area in order to maintain the water table at a level the roots can reach.

Harvesting Crop Residues

Some crop residues are sold as raw materials for manufacturing purposes. Each year industry is discovering new uses for certain plant materials that were once discarded as plant residue to be restored to the soil in the form of organic matter.

The uses of crop residues are:

Cornstalks - Insulation for buildings, corrugated paper, and livestock bedding.

Straw from Small Grain - Strawboard, corrugated strawboard, glue fillers, bleach papers and boards, and livestock bedding.

Sugarcane - Insulation for buildings, strawboard, corrugated paper, and fiber containers.

Flaxseed straw - Cigarette paper, paper for books, and other high priced paper used in printing.

Corncobs - Cob flour for glues, pipes, material for cleaning and burnishing metal, and wall board.

Proper Management Practices - Crop Residues

In the Great Plains region where water is an important factor in crop production, wheat yields have been improved by stubble mulching. The wheat residue helped catch and hold the moisture.

Corn yields were improved during dry years in Nebraska, if the land was protected the previous corn growing season by stubble mulching. Stubble mulching proved to be a better land care practice than either burning the residue or residue retained on the surface by subtillage.

In Ohio an experiment was conducted on burning cornstalks as compared to plowing under the stalks. Corn and wheat yields were greater on the plots where stalks were plowed under.

Experiments were conducted to reveal the difference in disposing of residues in the spring and fall. Little difference was shown in crop yields on spring plowed land as compared to fall plowed land. NOTE: Crop residues should be mixed with the soil at least three weeks before planting, if the residue has been shredded. Where insects are a problem the land should be plowed in the fall or early winter in order to eliminate the crop pests that remain in the plant residues.

Experiments have shown that crop residues help retain large amounts of minerals in the soil and help prevent leaching during excessive rainfall. Research has also shown that a soil high in organic matter maintains its structure.

SUGGESTED STUDENT ACTIVITIES

1. Fill in the blanks indicated below to make true complete statements:

   a. The part of the crop that remains on the soil after harvest is known as __________ __________.
   b. The usual three stages of plant decomposition are: __________, __________, and __________.
   c. About __________ __________ percent of the carbon is used as energy by soil organisms in digesting the plant residues.
   d. Most plant residues lack __________ for soil organisms to use in building their own body tissue.
   e. The carbon-nitrogen ratio is narrowed by applying __________ fertilizer to the residues.
   f. __________ plows usually cover the soil residue, leaving the surface bare.

2. Select the appropriate word for the statement below and write the correct word(s) in the blank space(s):

   Flaxseed straw
   Rotary choppers
   Plant residue
   Chisel plows
   Legume crops
   Disk plows
   Straw from small grain crops

   a. __________ protects the soil against water and wind erosion.
   b. __________ are used to break the compact layers of soil.
   c. __________ is used to make paper for books.
   d. __________ aid the decomposition of stalks and stubble.
   e. __________ are used to shred stalks and stubble.
   f. __________ is used to make strawboard.
   g. __________ leave most of the residue on the surface.

3. List some of the most common types of equipment used to destroy and process crop residue.

   a.
   b.
   c.
   d.
   e.
   f.

4. Define the following terms:

   a. Crop residue -

   b. Organic matter -

   c. Humus -

5. Briefly discuss the importance of properly disposing of crop residue.

6. Why is decomposition more rapid in leguminous plants than in non-leguminous plants? Discuss briefly.

7. Describe a chisel plow and discuss its use.

LAND PREPARATION

The first tillage implements were made of wood, stone, or bone. Tillage (seedbed preparation and cultivation) actually began before written records were used. However, Egyptian drawings dating about 6000 B. C. show that a type of hoe and plow were used. The hoe was used to dig or chop the soil. Crude instruments were also used to make holes in the soil for seeding and to cultivate plants. After animal was domesticated before the dawn of recorded history, it was used as draft power to drag a plow made of wood through the soil. This system of tillage and cultivation is still used in several countries of the world. Tree trunks and branches are used to make implements where animal power is being used.

The steel plow with sharp edged shares was developed in 1833. The plow was accepted even though many thought the iron plow would poison the soil. Implements, such as the disk plow, rotary hoe, harrow, and compactors became the more important types of equipment to stir, pulverize, and compact the soil.

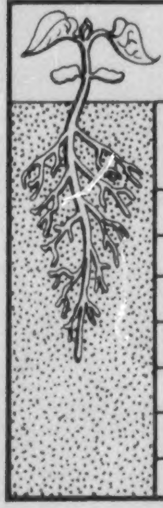
In 1731, Jethro Tull of England stated that plants fed upon the minute particles of the soil, and the finer the soil the more particles were available for the roots to absorb. But, during the nineteenth century, experimental evidence showed that plants needed certain chemical elements found in the soil, as well as water, air, and organic matter in order to grow and produce. Also, it was evident that soil should be in aggregate form instead of every particle being separate; the particles should stick together to make the aggregate or granule.

Three Basic Reasons for Tillage

The first basic reason for proper land preparation is to improve the soil's physical condition for seed germination and plant growth. This also involves the rootbed. The seedbed should be firm and yet not compact. A firm seedbed will allow adequate capillary action (movement of water from wet to dry areas from soil particle to particle) from the water table to the surface. This action breaks down if the soil is too loose. A firm seedbed will cause the seed to be in direct contact with the soil and permit an adequate oxygen supply.

A second reason for tilling the soil is to eliminate weed competition with the cultivated plant, even though it is not as important today as it was a decade ago. Chemicals are replacing tillage as a system of weed control on the seedbed and in the rootbed. Only about 5 percent of the plant's life is spent in the seedbed, whereas 95 percent is spent in the rootbed.

A third reason for using good tillage practices is to improve the soil's chemical and biological condition for seed germination and plant growth.



Characteristics of A Good Seedbed

Soil is:	
Fine, pulverized	Seed in direct contact with soil particles
Firm	Prevents drying. Good root hair medium
Loose and mellow	Permits air circulation and seedling growth
Free of trash and weeds	Trash and weeds shredded and plowed under
Fertile	Adequate plant nutrients
Free of insects	Approved practices observed
Free of plant diseases	Approved practices observed
Moist	Absorbs and holds water

The soil should be finely pulverized, yet maintain a porous characteristic. The seed must be in direct contact with the soil particles in order to receive adequate soil moisture. Small seeds require a finer seedbed than large seeds.

The soil should be firm enough to prevent rapid drying and furnish a good medium for tiny root hairs. This condition may be found in the lower four inches of the seven-inch seedbed.

The soil should be loose and mellow, especially the upper two or three inches. Loose soil will permit better air circulation and seedling growth. It is necessary that plant roots expand easily through the soil.

The soil should be free of trash and growing vegetation (weeds). Trash and weeds should be cut into fine pieces and plowed under during the fall, except where wind and water erosion is a problem.

The soil should be fertile in the seedbed in order that the young plant will have adequate plant nutrients for fast growth.

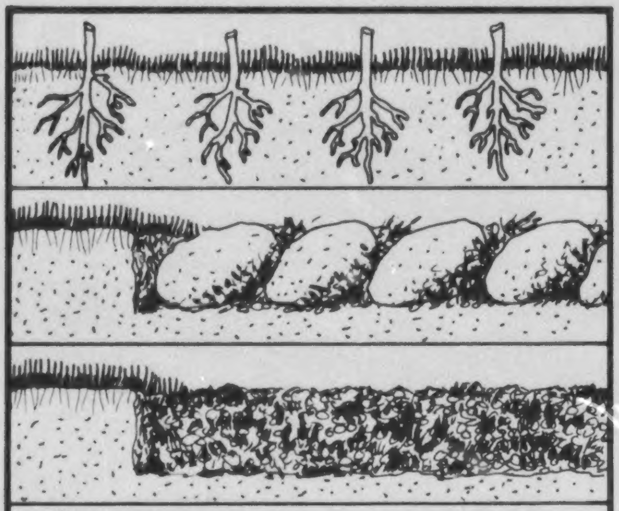
The soil should be free of insects. Crop rotation, use of insecticides, shredding of stalks and weeds, and fall plowing will help free the soil of insects.

The soil should be free of diseases. Crop rotation, fall plowing, and the use of fungicides help eliminate plant disease problems.

The soil should absorb and hold water for seed germination and plant development. Moisture dissolves the nutrients, making them available to the plant roots.

Methods Used In Seedbed Preparation

The methods used to prepare a good seedbed depend upon the type of surface cover, type of soil, and other factors. A soil is usually considered in good tilth if it contains 65 to 75 percent pore space. The type of equipment used for pulverizing the soil, covering trash, and putting the topsoil in contact with the subsoil to facilitate the rise of moisture is also a major factor in soil preparation. Climatic conditions are considered very important for seedbed preparation activities. Seedbeds should not be prepared if the soil is either too dry or too wet.



After the crop stalks have been shredded, the stubble land should be ready for plowing.

If the soil is disked before it is plowed, either with a disk or moldboard plow, good contact is made with the subsoil. But an ideal seedbed is not provided due to not disking the plowed soil. Organic matter is sandwiched between the layers of plowed soil.

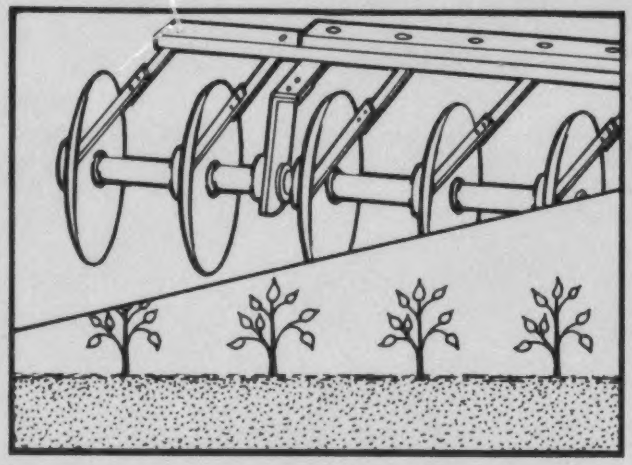
If the land is disked before and after plowing, the seedbed should be completely pulverized. This condition provides an ideal seedbed.

Soil that is plowed and then disked is usually not considered a good seedbed due to a lack of proper contact with the subsoil and too much air space between layers of plowed soil.

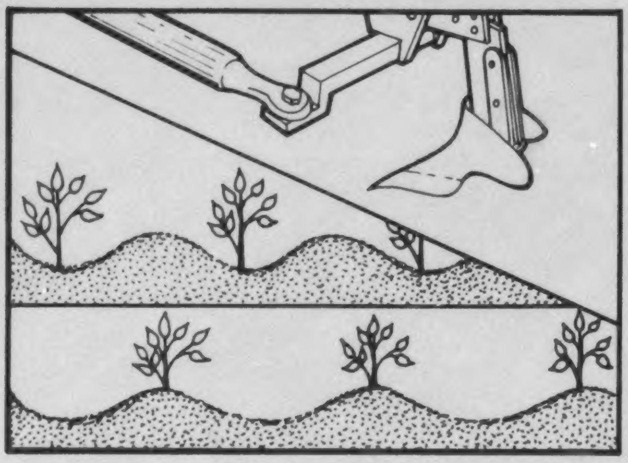
Usually if only a plow is used to prepare a seedbed, there will be a lack of contact with the unplowed soil and large air pockets will be created. This type of tillage is completely unsuitable for a seedbed.

Disk and moldboard plows are commonly used for seedbed preparation. The disk plow was originally introduced in areas of low rainfall, although it is considered a plow for sticky or waxy land. Due to the rolling and cutting action of the disk plows, there is a smaller problem with shredding and scouring in sticky soils. The moldboard plow is considered more efficient for seedbed-making if the soil is trashy. Organic matter should be sandwiched between furrow slices to take water into the soil. Water movement is stopped if the organic matter is at the bottom of the furrow. Even though the average seedbed may be from five to eight inches deep, disk and moldboard plows may break the soil much deeper. The depth of plowing is related to the type of soil, climate, residue, and future crops.

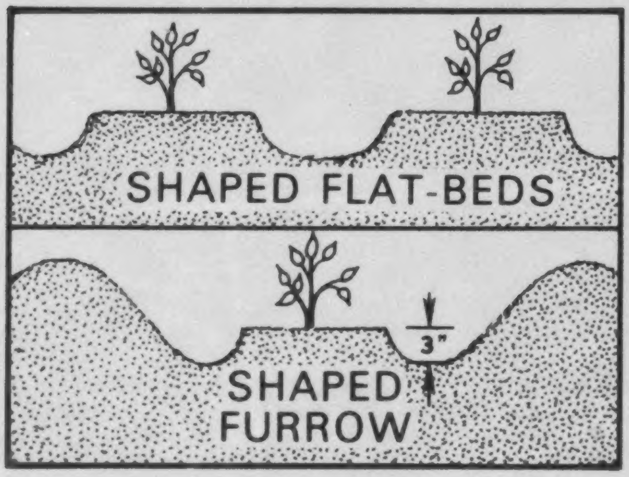
Some Common Types of Plows Used In Seedbed Preparation



Disk Harrow - The disk harrow may be used in preparing the seedbed for certain crops when it is not necessary to break the soil over six inches deep. It forms a mulch by pulverizing clods and mixing trash with the soil. This type of soil preparation is usually practiced when flatland planting or broadcast planting is performed. Disk harrows will destroy young weeds and grasses, but they do not bury insect infested trash or weed seed at a depth to kill insects or prevent weed seeds from sprouting during the growing season.

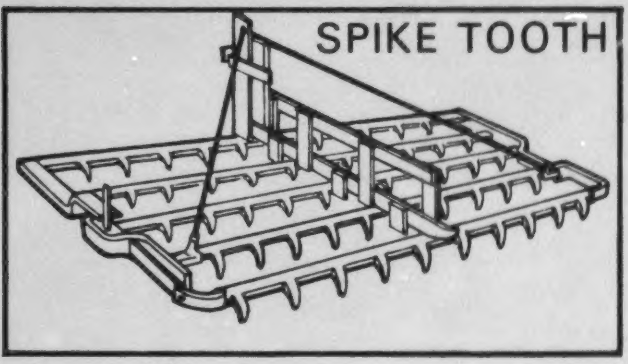


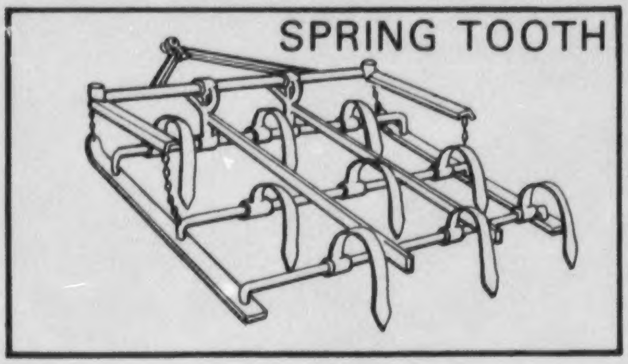
Lister or Middlebreaker Plow - The lister is used to prepare seedbeds for row crops. Listers throw the soil both ways, left and right, forming a ridge from about four to six inches higher than the furrow surface. In areas where there is excessive moisture during the planting season or where it is necessary to irrigate at this time, tops of the beds are used as the planting area. In regions of limited rainfall and wind problems, land is prepared so that planting is done in the furrows. If the lister is not used to plow out the first ridge, only half of the soil is stirred. Double listing (passing over the soil the second time) is practiced in some row crop areas.



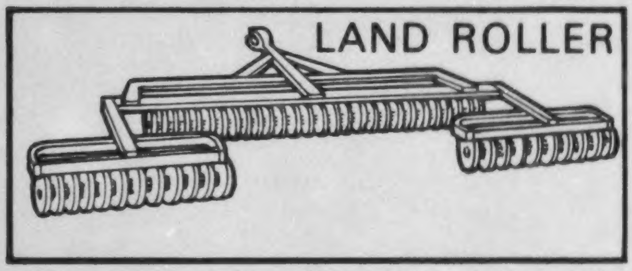
Lister - planter combinations are used to plant crops in rows. In some cropping areas the listed rows are harrowed down to desired planting level or shaped by special equipment before planting. The disk harrow is used before the soil is listed in some areas in order to form a more pulverized seedbed. The depth of plowing, about four to six inches below the surface, is not affected by the disk harrow.

Spike tooth and spring tooth harrows are used to smooth seedbeds by breaking up clods and crusted topsoil.



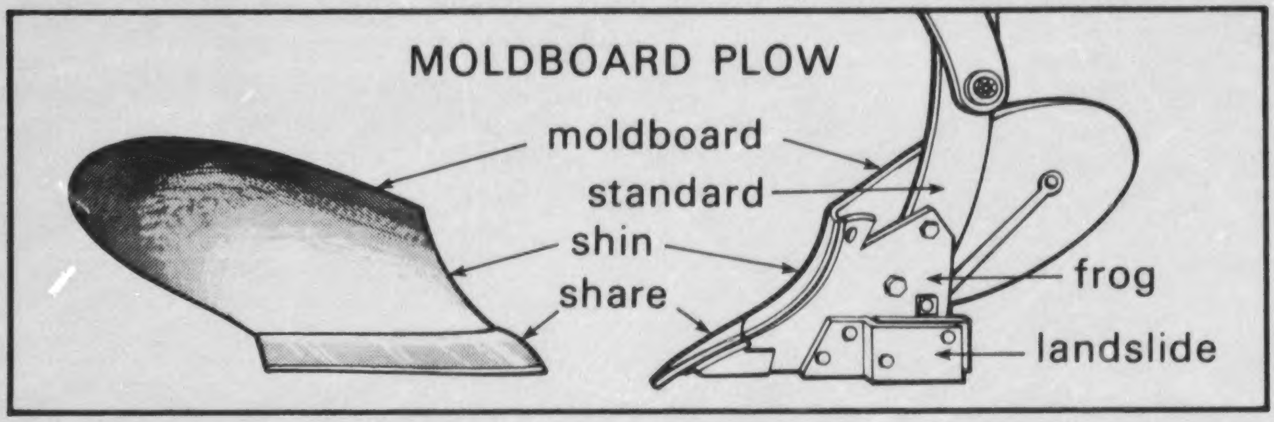


Harrows can also be used to level or lower the height of seedbeds or fill in furrow beds before planting. Usually a mulch is left on the seedbed after a harrow passes over it. In recent years land rollers or roller packers either separate or as part of a chisel unit are being used to shape and firm seedbeds.

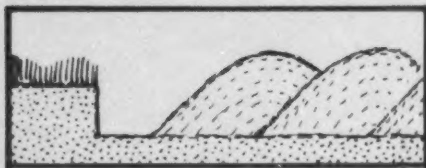


In some areas chisels and subsoilers are used with disk harrows for seedbed preparation. The chisel or subsoiler passes over the land followed by the disk. A small grain or regular forage crop drill follows the disk over the seedbed.

Moldboard Plow - The moldboard plow as discussed in Topic 1 is one of the most common pieces of equipment used for preparing land before planting. The side and back views of the plow show the following parts:

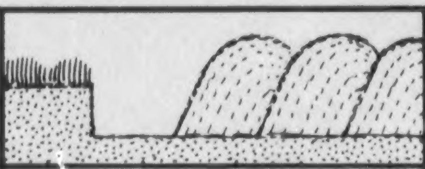


The angle or slope of a furrow slice is determined by several factors. Some of the major factors are: speed of plowing, moldboard curve, ratio of depth to width of cut, and levelness of plow bottom to soil. Proper and improper angles of furrow slices are shown below:



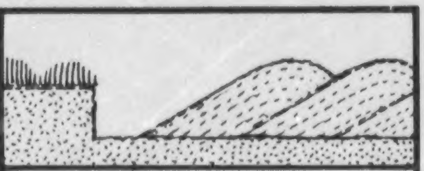
50 degrees ∠

Proper angle has slices at about 50 degrees.



70 degrees ∠

An angle of about 70 degrees is too upright.



35 degrees ∠

A 35 degree angle or slope is too flat.

The proper angle slice is made by plowing at the correct speed, using the right type of moldboard, operating plow in balance, and setting the plow to cut the proper width in relation to depth.

If the slope or angle is too upright, the plow is either operating too slow, it is running on its nose, the moldboard lacks curvature, plow "wings" over to unplowed land, or it is cutting narrow in relation to depth.

When the angle of the layers is too flat (about 35 degrees), the plow is either traveling too fast, the moldboard has an excessive curvature, or the plow is cutting too wide in relation to depth.

Procedures That May Be Used in Seedbed Preparation for Row Crops

As mentioned previously, land preparation varies according to the type of soil, climatic conditions, soil moisture, crop to be produced, the preceding crop on the land, and insect and disease problems. But, generally speaking, the seedbed preparation may include:

Plowing the soil when the soil moisture is right with a disk plow, moldboard plow, or disk harrow in the fall or spring may be desirable.

The soil may be disk harrowed or listed (bedded) in the spring.

A spike tooth harrow is then used to drag down the ridges.

It may be necessary to use a land roller or packer or shaper to firm the seedbed before planting the crop. Rollers are usually used on a flat soil surface.

Plowing with a lister or middlebreaker in the fall and relisting in the spring is a common practice in some areas.

Ridges or rows may be dragged down with a common drag or harrow.

If the ground is planted in rows, a relisting will take place by the use of a lister-planter.

Plowing with a chisel in the fall and early spring is practiced in small grain areas.

The final step in seedbed preparation is made by using a disk harrow. Usually disk harrowing is a plowing operation to level the soil, kill weed seedlings, make the soil fine, and help to compact it. Some small grain crop seedbeds are prepared by using only a disk harrow. Spring crops may require that the ground be disk harrowed soon after it is plowed, especially if weeds or ground crusting are problems.

The Proper Time To Plow

When to prepare a seedbed may be determined by the following factors:

The type of crop grown the preceding year may cause the seedbed to be partially prepared during the fall.

Weeds may tend to use the nitrates that may be lost due to leaching in heavy rainfall areas; therefore, plowing may be delayed.

Certain areas have heavy rainfall which causes a danger of water erosion. Late fall or winter plowing is considered unadvisable in such areas.

Where wind erosion is a problem the seedbed may be only chiseled in the fall, winter, or early spring.

A Comparison of Fall and Spring Plowing

Fall plowing advantages are:

Trash or crop residues have more time to decay and the soil has more time to settle.

The tillage load for preparing the seedbed in the spring is reduced. Crops can be planted earlier.

A rough surface is created to help hold the moisture in low rainfall areas, if the ground is not the type to erode easily.

There is a better chance to form a firm seedbed.

Spring plowing advantages are:

Practiced on land that erodes easily from wind and water.

Practiced on soil that lacks organic matter. Such soil runs together, thus creating a compact seedbed if such a soil is plowed in the fall.

Eliminates weeds in the early spring. A spring plowing will serve as one cultivation for the ground.

Fall plowing is usually preferred if the climate, soil, and type of crop permit the practice. Experiments with corn, oats, barley, and wheat in different parts of the United States show there is no production advantage between fall and spring plowing or seedbed preparation. Both systems of plowing produce about the same amount of grain per cropping season.

SUGGESTED STUDENT ACTIVITIES

1. Complete the following sentences:

   a. A disk harrow should not be used when it is necessary to break the soil more than ____________ inches deep.
   b. The ____________ (type of plow) is used to prepare seedbeds in furrows.
   c. The ____________ plow is the most common type of plow used to prepare seedbed.
   d. The angle or slope of plow slices should be about ____________ degrees if the soil is properly plowed.
   e. The angle or slope of the slice formed by a moldboard plow is too flat when the plow moves too ____________.
   f. The ____________ ____________ is one of the more recent pieces of equipment used to shape and firm the soil.
   g. Egyptian drawings show crude types of plows dating to about ____________ B. C.
   h. The first tillage tools were made of ____________, ____________, and ____________.
   i. Spike tooth and spring tooth harrows are used to ____________ seedbeds.
   j. A recommended way to properly prepare a seedbed is to ____________, then plow and ____________ again.

2. Place in parentheses the number of the word that makes the answer correct.

   a. What is the best angle of the soil slices when preparing land with a moldboard plow? ( )
      (1) 70 degrees
      (2) 50 degrees
      (3) 35 degrees
   b. What is considered a good method in preparing a seedbed when using a disk harrow and moldboard plow? ( )
      (1) Plow and then use the disk harrow
      (2) Use the disk harrow before and after plowing
      (3) Use the disk harrow before plowing
   c. A lister or moldboard plow is used in what way to prepare a seedbed? ( )
      (1) Plow the land flat
      (2) Form beds and furrows
      (3) Form only furrows
   d. What is the cutting part of a moldboard plow? ( )
      (1) Standard
      (2) Shin
      (3) Share
   e. What is considered an advantage of spring plowing? ( )
      (1) Used on land to eliminate or reduce wind and water erosion
      (2) Gives crop residues time to decay

(3) Prepares land so that crops can be planted earlier

3. Before each statement circle the T if the statement is true or the F if the statement is false.

T F a. Fall tillage reduces the load of preparing a seedbed in the spring.
T F b. Good tillage does not necessarily eliminate weed competition with the crop.
T F c. Every particle of soil should be separate instead of being in aggregate form in a good seedbed.
T F d. The disk plow is considered a better type of plow for clay or sticky soils than the moldboard plow.
T F e. Moldboard plows sandwich plant residue between the slices or layers.
T F f. Disk plows usually leave most of the plant residue at the bottom of the cut.
T F g. Furrow planting is practiced in areas with excessive rainfall.
T F h. There is no mulch left on the seedbed after the spike or spring tooth harrow is used.
T F i. Late fall or winter plowing is not recommended in areas with high winter rainfall.
T F j. It is not necessary that the soil be firm just before planting the crop.

4. Briefly discuss the following statements:

a. Explain how the disk harrow may be used in preparing a good seedbed.

b. What are the advantages of fall plowing?

c. Briefly describe a good seedbed.

d. How are spike and spring tooth harrows used in preparing a good seedbed?

e. Discuss the advantages of plowing land during the spring months.

APPLICATION OF FERTILIZER

More than a century ago a German scientist, Justus von Liebig, stated that we should return to the soil the plant food which is removed by crops. Liebig analyzed plants to determine what plant food was needed for growth. He showed that certain plant nutrients such as nitrogen, phosphorus, and potassium were used for growth purposes. Naturally such reasoning was centered around the type of farming that was in existence over 100 years ago. As early as 1849, superphosphate was being produced by treating phosphate rock with sulphuric acid. Plant growth was improved by adding this fertilizer to the soil.

Adding plant nutrients to the soil to increase plant growth is not a recent discovery. The ancient Greeks, Romans, and Chinese used fertility practices to improve plant production. Animal manure, fish, bone, marl (silt, sand, or clay containing calcium carbonate), chalk (a limestone), ashes, and guano (term usually used to identify bat and waterfowl manure) were the first fertilizers used. When the early settlers arrived on the North American Continent, they found the Indian using fish to fertilize his corn. Corn yields were increased by placing a fish beneath each hill of corn.

As early as 1920, the United States began producing enough for its use without adding more new land. In fact, there has been a very slight increase in land put into crop production since that date due to the increase in the amount of food and feed produced by the proper use of fertilizers and other crop improvement practices such as chemical control of insects and weeds, improved plants through breeding, and soil management practices other than the use of fertilizers.

The major purpose of fertilizing a soil is to enrich it, or make it more productive. Most soils do not contain adequate quantities of plant food; therefore, it is necessary to add fertilizers to help eliminate plant food deficiencies. Fertilizer is also applied to the soil to make farming a profitable business.

Plant Food Nutrients and Their Functions

There are twenty plant food nutrients considered essential to plant growth. They are divided into the following categories:

Macronutrients - which include nitrogen, phosphorus, potassium, calcium, sulphur, magnesium, and carbon, hydrogen, and oxygen.

Micronutrients include manganese, boron, copper, iron, zinc, molybdenum, and chlorine. Such nutrients as cobolt, sodium, silicon, and vanadium have little direct effect on growth, but they are essential to overall production.

Special functions of plant nutrients are:

Nitrogen - Vegetative growth depends upon nitrogen as a plant food. It must be applied, available in the soil, or furnished by leguminous plants. Nitrogen is readily available to crops, but it is also easily exhausted through soil erosion and leaching. Other effects of nitrogen on plant life include:

Makes the plant grow fast and gives it a dark green color.
Increases the quantity and quality of the leaf and adds to fruit and seed yield.
Increases the protein content in the plant.
Serves as a food for microorganisms while they decompose organic materials.

Phosphorus - Plants must have phosphorus in order to develop healthy roots and good seed and reach maturity early. Plants that receive adequate phosphorus get off to a good start early. Usually a very small amount is available as a plant nutrient in one growing season. Other effects of phosphorus on plant life are:

It stimulates early root formation and growth.
It brings about early maturity.
It helps bring about blooming and seed formation.
It makes plants (fall-seeded grains) more winter hardy.

Potash - This plant nutrient helps make strong stalks and helps form a good root system. Other effects of potash on plant life are:

It makes plant resistant to diseases and reduces lodging.
It increases fullness of grain or seed.
It aids in the transfer of starches, sugars, and oils.
It gives winter hardiness to the plant.

Calcium as a Secondary Plant Nutrient - Calcium is used in large quantities in some areas due to its being an active ingredient of lime. Soil with a high acidity (pH) content requires the application of lime. Other effects of calcium on plant life are:

It is essential for root growth plant vigor and stem stiffness.
It neutralizes poisons produced in the plant.
It is essential to grain and seed formation.
It adds calcium to food and feed crops.

Magnesium as a Secondary Plant Nutrient - This plant nutrient helps correct the soil acidity and is an essential part of the plant chlorophyll. Other effects of magnesium on plant life are:

It aids in giving a green color to the plant.
It is essential for the formation of sugar in the photosynthesis process.
It serves as a carrier of phosphorus in the plant.

Sulphur as a Secondary Plant Nutrient - Plants may use as much sulphur as they do other secondary nutrients, including phosphorus, a primary nutrient. It is considered important in protein building in the plant. Other effects of sulphur on plant life are:

It is essential in chlorophyll formation, and it helps the plant maintain a dark green color.
It increases root growth and nodule formation on legumes.
It is essential to seed production and the general vigor of plant growth.

Micro Plant Nutrients - The micro plant nutrients are known as trace-element plant food nutrients. These nutrients are not found in all fertilizers, even though most of them are important to plant growth. Their functions are:

Boron improves quality in crops and seed of leguminous plants.
Iron is important in the production of green matter in plants.
Copper is important in seed setting.
Manganese increases the availability of phosphorus, calcium, and magnesium, and aids in plant food manufacturing.
Zinc is essential to plant growth.
Chlorine is seldom efficient in field crop production, but it is essential to plant growth.
Molybdenum is used by legumes in nitrogen fixation. It is also important to the production of certain vegetables.

Nonmineral Nutrients - Carbon dioxide and water are the sources of carbon, hydrogen, and oxygen, the nonmineral nutrients. As stated previously, these elements are used in the photosynthesis process.

$$\underset{\text{Carbon Dioxide}}{6CO_2} + \underset{\text{Water}}{12H_2O} \longrightarrow \underset{\text{Oxygen}}{9O_2} + \underset{\text{Carbohydrates}}{6(CH_2O)}$$

Reduced plant growth will appear if there is a lack of carbon dioxide, water, or light.

Some Common Types of Fertilizer Used in Seedbed Preparation

The grade of a fertilizer is expressed in its macronutrient content which means the nutrient percentage by weight. These percentages are given in three numbers. The first number gives the percent of nitrogen (N), the second number phosphorus pentoxide (P_2O_5), and the third number potassium oxide (K_2O). If a bag of fertilizer is numbered 12-12-12, this means it contains 12 percent N, 12 percent P_2O_5, and 12 percent K_2O. The remaining 64 percent consists of other materials such as chlorine, calcium, oxygen, and inert ingredients.

Some of the most common types of fertilizers used to supply nitrogen to the seedbed include:

Ammonium nitrate, a solid nitrogen fertilizer, that contains 32.5 to 33.5 percent nitrogen and is completely soluble in water

Ammonium sulphate, a solid nitrogen fertilizer, which contains 20.0 to 21.0 percent nitrogen and is soluble in water

Urea, a solid organic nitrogen compound, which contains 45 to 46 percent nitrogen

Sodium nitrate, calcium nitrate, and calcium cyanamide, solid nitrogen fertilizers that contain 16, 17, and 21 percent nitrogen respectively

Anhydrous ammonia, a gaseous nitrogen fertilizer containing 82 percent nitrogen (Refer to Table I)

Phosphorus may be supplied to the seedbed by adding the following phosphates:

Superphosphate, a rock phosphate treated with sulphuric acid, contains about 20 percent phosphorus.

Triple superphosphate, a rock phosphate treated with phosphoric acid, contains about 45 percent phosphorus.

Liquid phosphoric acid, a liquid fertilizer, contains about 52 percent phosphorus. It may be applied with anhydrous ammonia.

Ammonium phosphates. A reaction of anhydrous ammonia and phosphoric or sulphuric acid, forms ammonium phosphates, such as 16-20-0 and 21-53-0.

Fertilizers that supply potassium to the seedbed are potassium chloride and potassium sulphate. Potassium chloride contains about 60 percent available potassium, and potassium sulphate contains about 50 percent potassium.

Mixed fertilizers are used to supply plant nutrients to the seedbed if more than one nutrient is needed. For example, 1:1:1 (8-8-8) may be the proper ratio to use. It contains eight percent nitrogen, eight percent phosphorus, and eight percent potassium or 8 pounds of nitrogen, 8 pounds of phosphoric acid and 8 pounds of potash per 100 pounds of total ingredients.

Calcium as a plant nutrient is supplied by adding limestone, gypsum, burned lime, and oystershell to the seedbed.

Magnesium as a plant food is supplied from dolomitic limestone. Another source of supply is Epsom salts. (Magnesium sulphate)

Sulphur may be supplied in the form of elemental sulphur, ammonium sulphate, superphosphate, or gypsum. (calcium sulphate)

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(4) Soil structure -

(5) Preplant irrigation -

b. What are three principal ways of supplying water to the soil?

(1)
(2)
(3)

c. List four sources of water supply and briefly discuss each source.

(1)

(2)

(3)

(4)

d. How many gallons will a well produce per minute if it flows at the average rate of 2.0 cu. ft. per second?

2. Fill in the blanks indicated below to make true complete statements:

a. By 1985, there should be about ____________ acres of land in the United States under irrigation.
b. During this same period (1985) it is estimated that Texas will lose ____________ acres of irrigated land.
c. The amount of water to cover one acre one foot deep is known as ____________, and this amount of water is equal to ____________ cubic feet.
d. Water that is supplied below the root zone but near the surface is known as ____________ irrigation.
e. The border method of irrigation is used to produce the following crops: ____________, ____________, ____________, and ____________.
f. Water in a flowing stream is usually measured in ____________ per second.
g. Most of the water used by the plant is found within ____________ (distance) of the surface.
h. Fruit trees (leaves) appear ____________ if they are in great need of water during the hottest part of the day.
i. Soil moisture is very important in an orchard during ____________ development.
j. The High Plains area in West Texas is irrigated entirely from ____________.

3. Underline the word True if the statement is true or underline the word False if the statement is false.

a. Perennial streams were one of the first sources of water supply for irrigation. True or False?
b. If the plant uses 40 percent of the available moisture in the top one-fourth of the root zone depth, it is not important that the soil contain moisture throughout the zone. True or False?
c. If 50 to 75 percent of the available soil moisture remains in the root zone, a medium texture soil forms a ball with pressure. True or False?
d. The depth of root penetration can depend on the type of soil layering if adequate moisture is available. True or False?
e. Water flows at a faster rate in the center of a stream than along the banks. True or False?
f. Irrigation is practiced in some areas to dilute or wash out salts that have become concentrated in the soil. True or False?

Trace elements, iron, copper, zinc, manganese, and boron, may be applied to seedbed soils in sulphate form except boron and iron. For example, copper is supplied as copper sulphate. Boron is supplied in the form of borax. Iron is supplied as iron oxide.

Some common types of commercial fertilizers to apply to the seedbed are: 12-12-12, 13-13-13, 16-20-0, 16-6-12, 8-16-16, 0-20-20, 5-10-5, 0-10-30, 8-32-16, 6-24-12, and 0-15-45. Ammonium nitrate, ammonium sulphate, anhydrous ammonium, calcium cyanamide, urea, superphosphate, and aqua ammonia are also commonly used fertilizers. A 5-10-5 fertilizer contains 5 parts nitrogen, 10 parts phosphorus, and 5 parts potash.

Crop residue and barnyard manure furnish plant nutrients for maintaining soil fertility in the seedbed.

Leguminous crop residue supplies the seedbed with nitrogen and organic matter. Nonleguminous green manure crops also furnish plant nutrients, but they furnish less nitrogen.

Animal manure is considered a good source of a complete fertilizer for the seedbed. A large quantity of manure is required to produce a small amount of the three major elements. Generally, one ton of animal manure contains ten pounds of nitrogen, five pounds of phosphoric acid, and ten pounds of potash. The nutrient content varies according to the type of animal and the type of feed the animal receives. Several types of dried livestock manures are sold as fertilizer.

Table I may be referred to when determining the percent of the three major elements plus the percent of calcium, magnesium, and sulphur in fertilizer materials.

PLANT NUTRIENTS IN FERTILIZER MATERIALS

Table I

Materials	Nitrogen N%	Phosphorus P_2O_5%	Potassium K_2O%	Calcium %	Magnesium %	Sulphur %
Ammonium Nitrate	33.5	—	—	—	—	—
Ammonia Sulphur Solution	70	—	—	—	—	10
Ammonium Sulphate	21	—	—	—	0.3	23.7
Ammonia, Aqua	22	—	—	—	—	—
Urea	45	—	—	1.5	0.7	.02
Sodium Nitrate	16	—	0.2	0.1	.05	.07
Calcium Nitrate	15.5	—	—	19.4	1.5	.02
Calcium Cyanamide	21	—	—	38.5	.06	0.3
Anhydrous Ammonia	82	—	—	—	—	—
Superphosphate	—	20	0.2	20.4	0.2	11.9
Liquid Phosphoric Acid	—	58	—	—	—	—
Ammonium Phosphate	11	48	0.2	1.1	0.3	2.2
Potassium Chloride	—	—	62	—	0.1	0.1
Potassium Nitrate	13	—	44	—	—	—
Potassium Sulphate	—	—	53	0.5	0.7	17.6

---

g. About 20 percent of the irrigated crops grown in the U. S. are irrigated by methods other than wells. True or False?
h. China was one of the first countries of the world to pioneer irrigation. True or False?
i. Soil structure means the size of the individual soil particles. True or False?
j. The depth of water penetration should be determined a day or two after irrigation. True or False?

NOTES

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Factors to Consider in Applying Plant Nutrients

Different plant-food elements move at different rates and distances in the soil from point of placement. For example, nitrogen may move readily under favorable conditions, whereas phosphates usually move a short distance from where applied. Potash is considered less soluble than nitrogen but more soluble than phosphate; therefore, its rate of movement is usually between that of nitrogen and phosphate.

Commercial fertilizers should be applied the proper distance from the seed or roots of plants unless it is broadcast on the surface (top-dressed) or top-dressed and plowed into the soil or applied in irrigation water. Excessive amounts of nitrogen and/or potash applied near the seed or roots may cause injury if drying conditions increase the concentration of plant-food elements (nitrogen and potash).

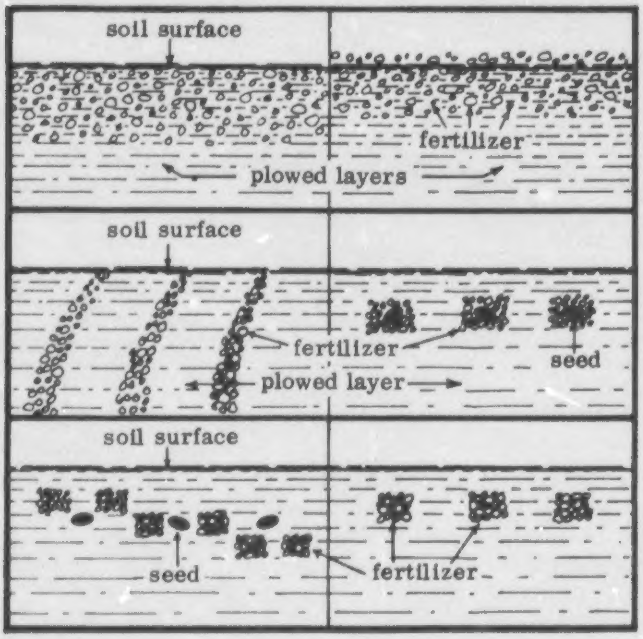
It is considered desirable to apply fertilizer as near the seed or roots as possible without injury to either seed or roots for the following reasons:

Soil fixation of plant-food elements are reduced if the fertilizer is properly applied.
Fixation increases as fertilizer is applied farther away from the seed or plant.
If fertilizer is applied in bands near the plant root, it is less available to growing weeds.
Properly placed fertilizer gives a greater return in quantity and quality for a plant production program and results in a larger net return for the produce when marketed.

Fertilizer should be applied to make the plant nutrients available for plant use when they are needed. Application of fertilizers may be made prior to planting, during planting, or after the crop is growing. However, anhydrous ammonia is not generally used in the seedbed at planting time. It may be used about 30 days before planting or as a side dressing fertilizer.

Seedbed Application

Fertilizer may be applied in the following ways:



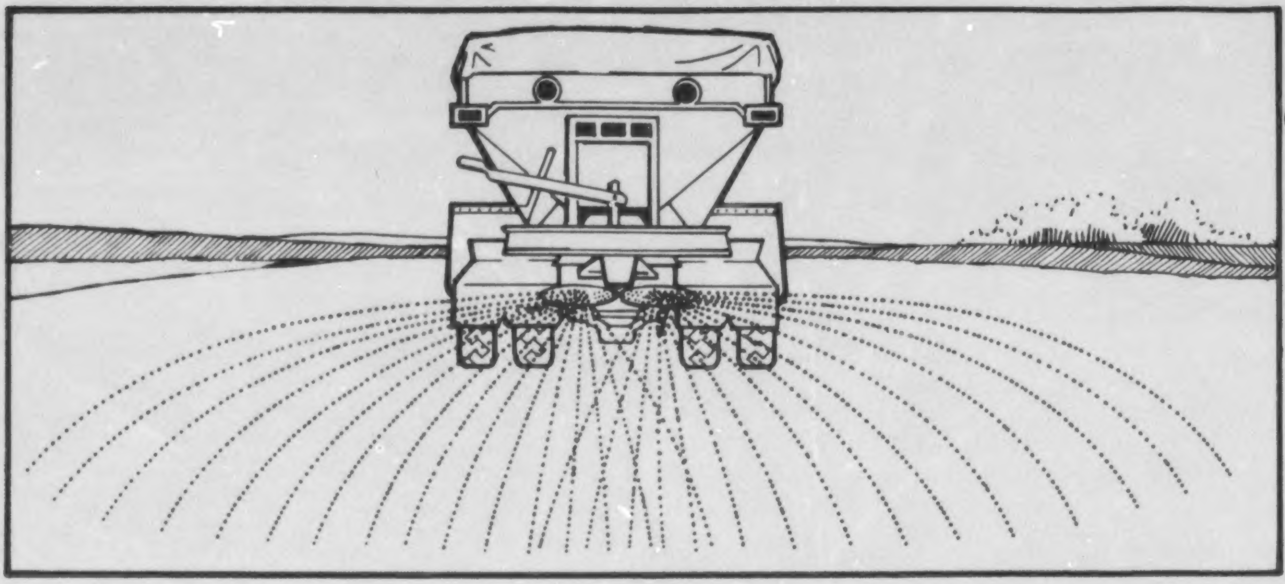
Broadcast on the surface and the soil disked or plowed to mix the fertilizer with the soil.
Broadcast on the surface as when fertilizing pasture land. After broadcasting the land is not disturbed.

Broadcasting and plowed into the soil with a lister creating fertilized bands the width of the seedbeds.
Drilled into the soil with the seed.

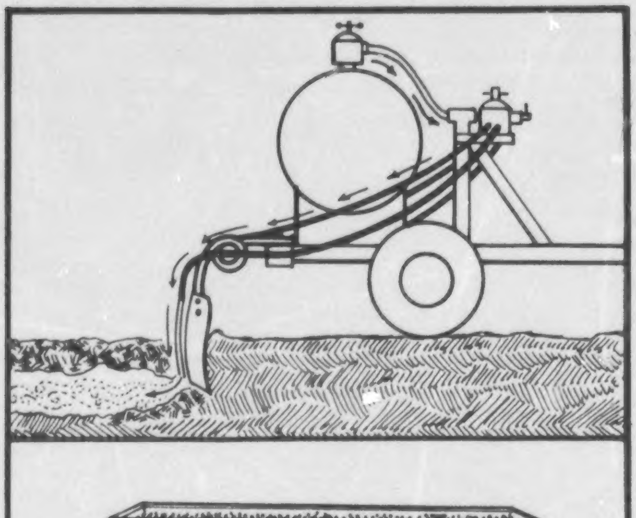
Drilled into the soil above, on each side or below the seed.
Applied or drilled into the soil at the bottom of the planter furrow.

Fertilizer Application Equipment

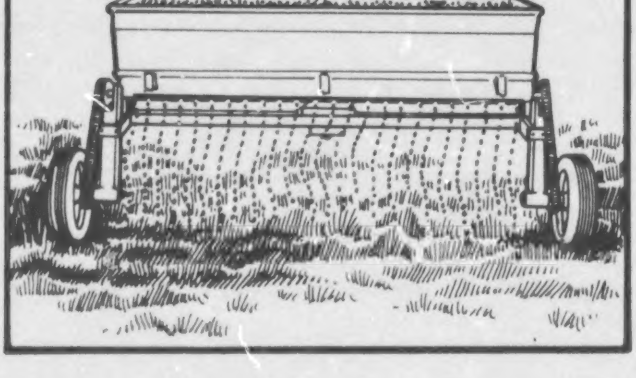
There are many types of fertilizer equipment used for distributing gas, liquid, and solid types of fertilizers. The most common types are:



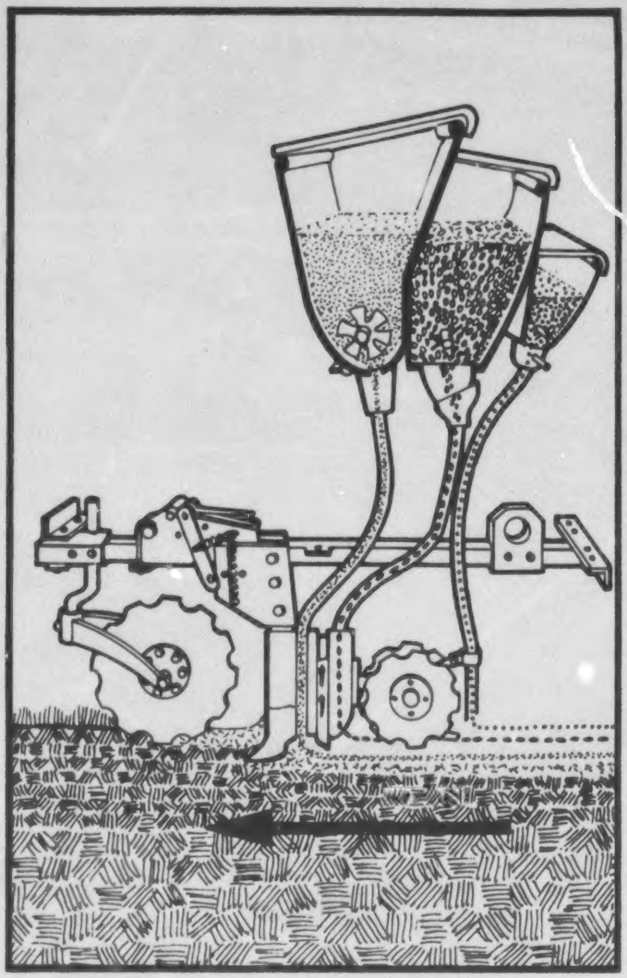
Spinner Spreader - The double spinner spreader truck applicator broadcasts solid fertilizers over a wide area. This type of equipment is used mainly to spread the dry chemicals on native and cultivated pasture lands. There are also double and single spinner-spreaders that can be mounted on the rear of tractors and operated off the PTO. The drag type spinner-spreader is partially operated from the PTO. The hopper drag chain is usually operated from the equipment wheels.



Subsurface Applicator - Both low- and high-pressure applicators are used to apply solutions below the soil surface. The subsurface method prevents the loss of ammonia, especially if the soil is slightly packed behind the chisels or injector blades. Applicators of this type may have tubes attached to blades, knives, disk standards, moldboard standards, and cultivator standards. The fertilizer solution is metered into the furrow opening and the soil is slightly packed to seal the opening.



Drop-Type Distributor - The drop-type distributor is also referred to as an end wheel distributor because the feed shaft is usually driven by ground wheels. However, certain brands are PTO driven. Solid fertilizer material is usually dropped in narrow bands from the adjusted openings in the distributor hopper. This type of distributor usually holds a smaller amount of fertilizer (1,000 to 2,000 pounds) than the pull-type spinner-spreader which will hold up to about 10,000 pounds. Drop-type distributors like the spinner-spreaders can be used for surface spreading on seedbed, growing crops, and pasture.



Drill-Multiple-purpose drills have one compartment or hopper that is used for fertilizer, one for grain, and a small hopper for grass seed. The fertilizer is placed below the seed when using this type of equipment. Grain is then placed above the covered fertilizer, and grass is usually sown on the surface above the grain. Drag chains or covering disks are used on these types of drills. Row crop planters operate similarly to multiple-purpose drills. They may be equipped to place the fertilizer from the special hopper directly below or below and to one side of the seed. These units are equipped with two separate hoppers.

Factors to Consider When Applying Fertilizer

Some general factors to consider when applying fertilizer are as follows:

- ✱ Soil Requirements - The amount of plant food available for a specific crop. The information can be derived from a soil test.
- ✱ Plant Characteristics - Plants have different rooting characteristics; therefore, it is necessary to consider the root zone.
- ✱ Soil Characteristics - Soil structure, texture, and chemical characteristics are important factors. The plant nutrient requirements on a deep sand loam is different from those on a shallow clay loam soil.
- ✱ Available Moisture - It is often said that fertilizer and water go together. Moisture can influence the amount, kind, method of application, time of application, and economics involved in the application of fertilizer.

SUGGESTED STUDENT ACTIVITIES

1. Complete the multiple - choice questions by selecting the correct word and recording the number.

   a. Phosphorus may be added to the seedbed in greater quantities when using the following fertilizer:
   (1) Superphosphate, (2) Liquid phosphoric acid, (3) Triple superphosphate. ( )

   b. The correct meaning for a grade of 16-20-0 is:
   (1) 0 percent of nitrogen, (2) 16 percent potassium, (3) 20 percent phosphorus. ( )

   c. A primary fertilizer element is:
   (1) Iron, (2) Potassium, (3) Manganese. ( )

   d. Anhydrous ammonia should be applied as follows:
   (1) About one month before the crop is planted, (2) At the time the crop is planted, (3) After the crop has been planted. ( )

   e. What type of fertilizer was used by the Indians when the early settlers arrived on the North American Continent? (1) Guano (bat and waterfowl manure), (2) Animal manure, (3) Fish. ( )

   f. What trace element is used by legumes in nitrogen fixation?
   (1) Boron, (2) Copper, (3) Molybdenum. ( )

   g. Calcium is a plant nutrient that is supplied by adding the following to the soil:
   (1) Gypsum, (2) Magnesium sulphate, (3) Dolomitic limestone. ( )

   h. Pasture land is fertilized in the following manner:
   (1) Subsurface application, (2) Wide band application, (3) Broadcast application. ( )

   i. The drop-drill distributor is used to apply fertilizer in one of the following ways:
   (1) Subsurface, (2) Broadcast, (3) Below and on surface in small bands. ( )

j. Fertilizer is placed in the soil at the same time small grain is sown by: (1) Using a subsurface applicator, (2) Spinner-spreader, (3) Drill applicator combination. ( )

2. Answer the following questions:

a. What were the first fertilizers used to improve plant production?

b. In what ways can fertilizer be applied in the seedbed?

c. What are some of the common types of equipment used to apply fertilizer?

d. Why is nitrogen considered a major macronutrient?

e. What is the meaning of 12-12-12 and what are the chemical formulas of each?

3. Discuss the special functions of nitrogen, phosphorus, and potassium.

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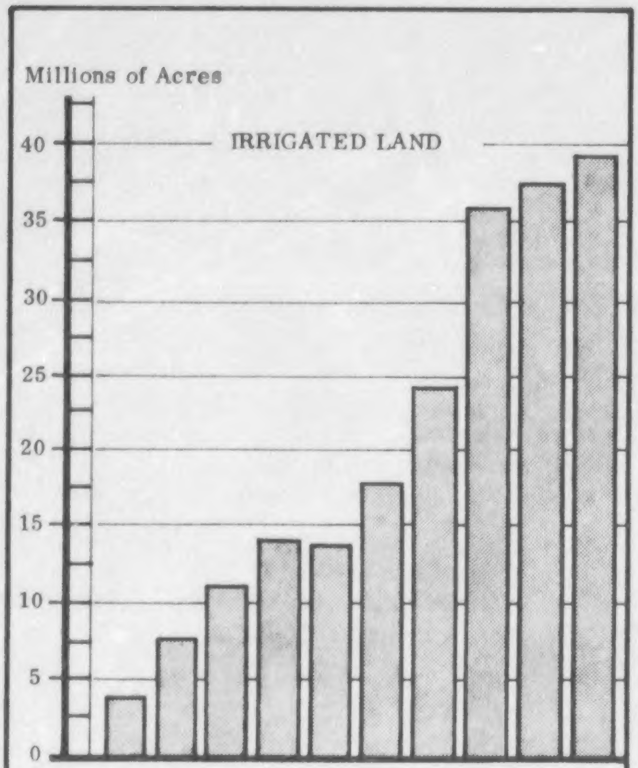
IRRIGATION

Irrigation practices began thousands of years ago in areas where the rainfall was inadequate for crop production certain seasons of the year. For example, water from the Nile River was used to irrigate crops in the desert lands of Egypt about 330 B.C. The world's oldest dam was built on this river over 5,000 years ago. It furnished water for human and animal consumption and irrigation purposes. At least 4,500 years ago the Chinese also began developing irrigation systems to irrigate their crops. It is believed that they developed the water ladder for lifting water from streams and reservoirs. Early methods used to lift water were the bucket and counterweight pole, chain of pots on an endless rope, and the water screw. China built the Tu-Kiang Dam in about 200 B.C., and it is still used to furnish irrigation water for about 500,000 acres of rice. The Sui Empire (589–618 A.D.) constructed the 700-mile-long Grand Canal in China to furnish irrigation water for rice and domestic consumption.

Early writings point out that the country south of India was very prosperous because two crops per year were harvested from the fertile land. Irrigation practices permitted Ceylon to produce an abundance of food in the semiannual harvest.

The Indians of North America constructed canals in the arid regions of the west to irrigate their corn crops. It is estimated that these practices existed as early as 700 A.D. The second group of people to develop irrigation practices in the western United States were the early Spanish priests. Their irrigation projects were usually small (gardens, orchards, and vineyards). The Mormons also poineered irrigation for crop production in the West about the middle of the nineteenth century.



In 1890, over three and one-half million acres of land were under irrigation in the Western United States. It is estimated that the amount of land irrigated will continue to increase and by 1985 there should be about 38,000,000 acres in the United States being irrigated for crop production. In some areas in the different states the water table is declining where wells are being used as the main source of water supply. By 1985, it is estimated that Texas will lose about 840,000 acres of irrigated land due to declining water tables. About 80 percent of the irrigated land in the state receives water from wells. Another factor that is beginning to influence the loss of irrigated productive land is the cost of fuel to operate well pumps. There has been a large reduction of irrigated acreage in the Trans-Pecos and High Plains areas of the state. Irrigation accounts for over 2/3 of the total value of all crops produced, yet less than half of all the land in production is irrigated.

The Meaning of Irrigation

There are several definitions that may be applied to the term irrigation.

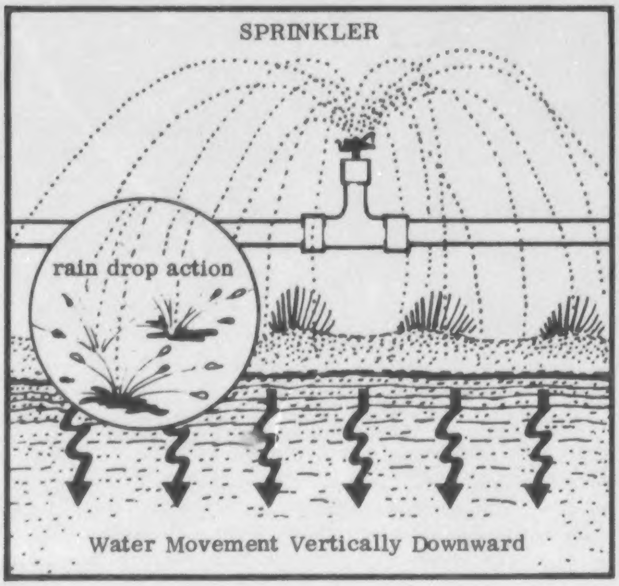
Irrigation is a way of supplying water to the soil artificially. It is a means of maintaining a continuous supply of moisture to plant seeding and plant root zones in the soil.

The meaning of irrigation is expressed in the following objectives:

- To add water to the soil in order to insure prompt seed germination (Preplant irrigation).
- To provide the proper amount of water for plant growth (Post-plant irrigation).
- To reduce the chance of producing a short crop due to drought (Preplant and Post-plant irrigation).
- To make a more favorable plant environment for plant growth, either by cooling the soil or protecting the plant from a freeze. Also, plow pans are softened by adequate soil moisture.
- To dilute or wash out salts that become concentrated in the soil.
- To improve the quantity and quality of crops produced.
- To supply water to crops where the rainfall is adequate but not distributed properly during the growing season.

Principal Methods of Irrigation and Features to Consider

The principal methods of supplying water to the soil are:

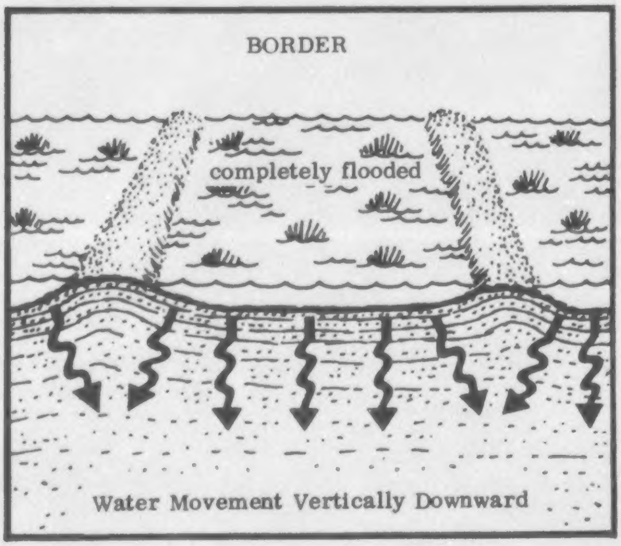


Sprinklers - Water is sprayed through the air, similar to rainfall, by sprinklers that are operated at pressure up to 120 pounds. Water movement is downward in the soil. Perforated pipe or tubing is also used in the sprinkler method of irrigation.

Crop adaptability - All major farm crops except rice.

Soil adaptability - All irrigatable soils suitable for growing field crops, perennial grasses, and legumes. This method is especially adapted to sandy soils that take in water rapidly.

Other features to consider - Sprinklers offer a good method to irrigate too steep, too shallow, or too rolling soils; water can be controlled to provide uniform wetting; the initial and operating costs are expensive; evaporation rate may be high due to weather conditions; and labor cost may be high due to pipe movement.

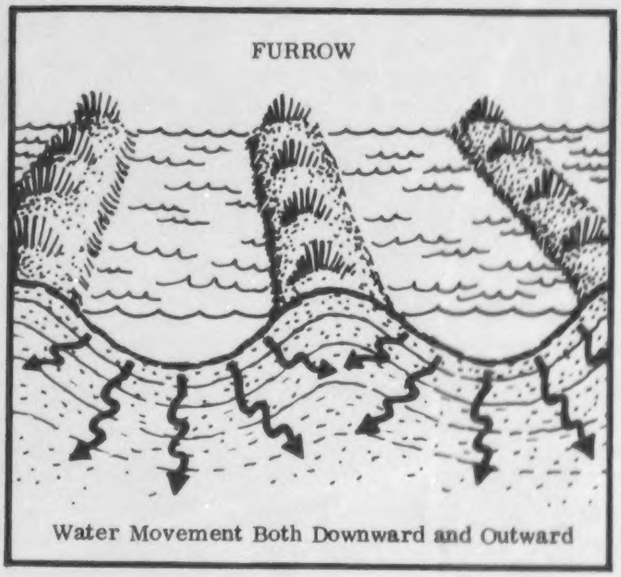


Surface Irrigation - Water flows by gravity in furrows or over the ground surface where it is controlled by borders, dams, and gates. Water movement is downward and outward in rows and downward in border irrigation.

Crop adaptability - Furrows are used for row crops; contour borders are used for rice, pasture, small grain, or orchards; graded borders are used for pasture, small grain, and hay crop irrigation.

Soil adaptability - Medium to fine textured soils with not more than two feet of slope per 100 feet.

Other features to consider - Initial cost is usually less than sprinkler (overhead) irrigation; labor costs are low; insecticides can be used on the foliage; may require land leveling; and graded borders may interfere with farming.



Subsurface Irrigation - Water is supplied below the root zone but near the surface. Subsurface water can be supplied to the plant in open ditches or by using pipe that contains tiny holes. Capillary action carries water to the plant roots.

Crop adaptability - Furrows and pipe may be used for row crops to furnish plant moisture below the root system. Pipe may be used for non-row crops.

Soil adaptability - Medium to fine textured soils with moderate to no slope and clay or rock to slow the downward movement of water.

Other features to consider - Labor costs are low, but the initial cost is high. It is a good method to use to eliminate evaporation and aid in controlling plant diseases.

Sources of Water Supply

Perennial streams were one of the first sources of water supply for irrigation. Since 1930, dams have been constructed on the streams, eliminating their dependence on rainfall for an adequate irrigation water supply. Many perennial streams are fed by springs and high snow covered areas in mountain regions, but most streams of this type have a continuous supply of water furnished by rainfall and springs.

Reservoirs, ponds, and lakes impound water from drainage areas to irrigate a limited acreage. Reservoir, pond, and lake water is limited due to the following factors:

Water requirements or crops to be irrigated.
Application efficiency of the irrigation system.
Losses due to evaporation and seepage.
The amount of rainfall and water held in storage.

Canals and pipelines are major sources of water where communities have organized irrigation districts. Water usually comes from reservoirs and streams and is controlled by a water control agency.

Wells are considered one of the most dependable sources of irrigation water. Only deep wells that are drilled or put down by tamping are used to supply irrigation water. Wells are a major source of water supply in certain areas. The High Plains area of Texas received its entire supply of irrigation water from deep wells.

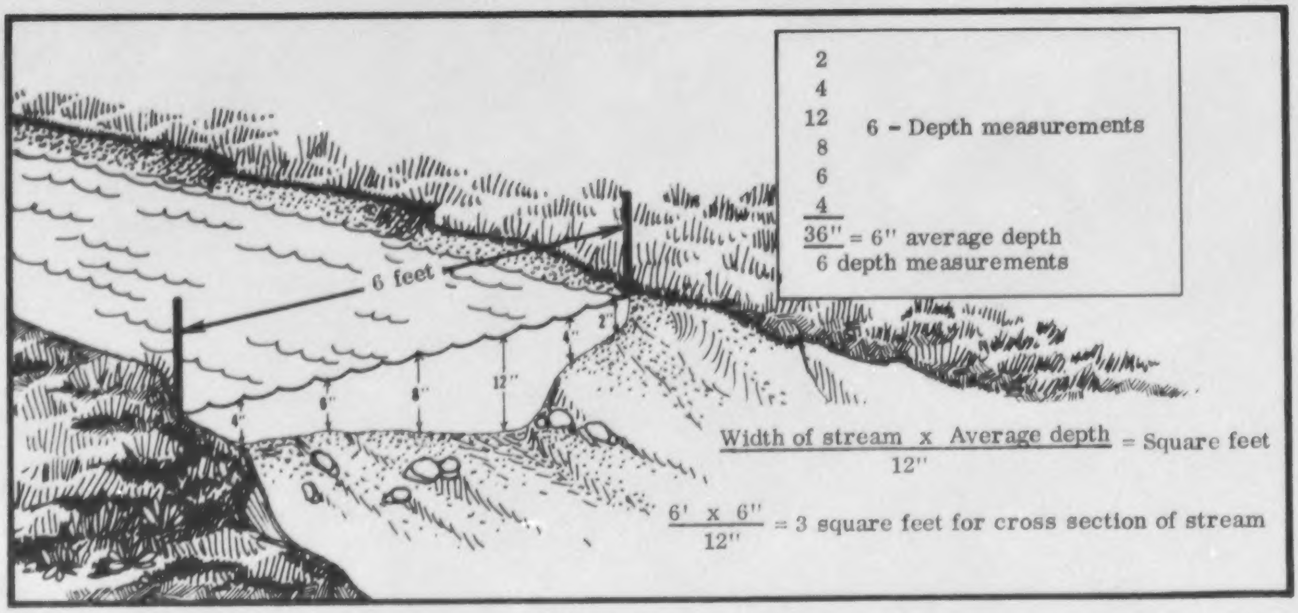
How Water Flow Is Measured

One acre foot of water means the amount of water required to cover one acre one foot deep. This amount of water is equal to 43,560 cubic feet. Water may be measured in gallons per minute, acre inches per hour, or cubic feet per second.

Several measurement formulas have been developed to determine the amount of water that flows through various sizes of weirs and orifices. In most cases tables and charts containing information on the cubic feet per second water discharge are used to determine the amount of water that flows through orifices and weirs.

Some of the more common ways used are:

Stream Flow - First locate a straight run in the stream, then measure the width of water and take several depth measurements at the place the width measurement was taken. Determine the cross-sectional area of the stream in the following manner:



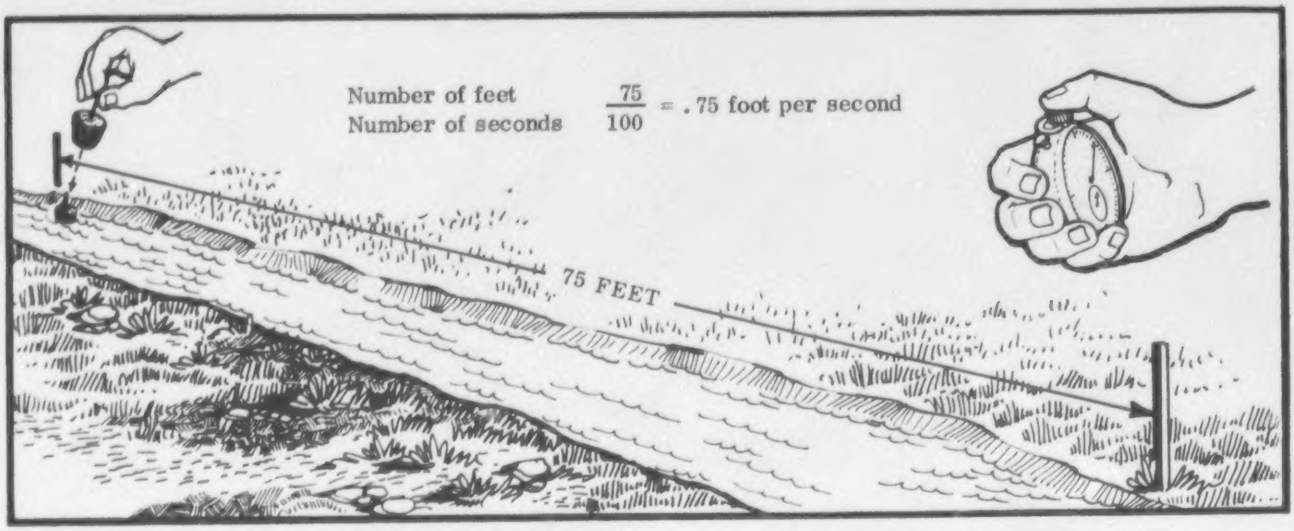
2
4
12 6 - Depth measurements
8
6
4

$$\frac{36''}{6 \text{ depth measurements}} = 6'' \text{ average depth}$$

$$\frac{\text{Width of stream x Average depth}}{12''} = \text{Square feet}$$

$$\frac{6' \text{ x } 6''}{12''} = 3 \text{ square feet for cross section of stream}$$

The next step is to check the rate of flow. This can be measured in feet per second. A watch, float (cork), and tape measure may be used in this step. The procedure is as follows: Measure a desired distance on the stream, drop the float in the moving water, and begin timing in seconds with the watch. Example:



$$\frac{\text{Number of feet}}{\text{Number of seconds}} \quad \frac{75}{100} = .75 \text{ foot per second}$$

To determine the amount of water flowing in the stream or canal, the following method is used:

Multiply the cross-section of the stream by the average rate of flow.
3 sq. ft. x .75 ft. per second = 2.25 cubic feet per second

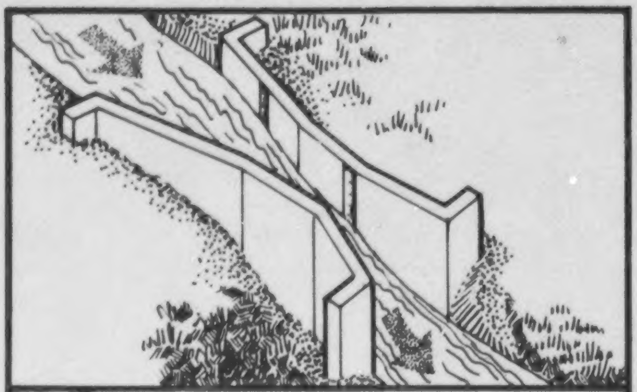
In order to get the average velocity a factor of .8 multiplied by the speed of flow is used. Example: 2.25 cubic feet per second times .8 = 1.8 cubic feet per second

This factor is used because the water in the center of most streams or canals moves faster than along the banks.

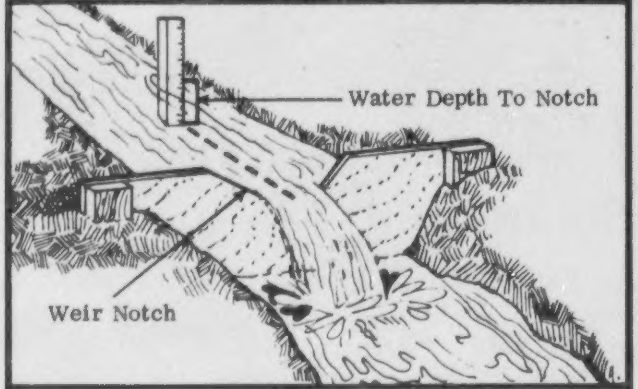
The following procedure is used to convert cubic feet of flow per second to gallons per minute:

The first step is to convert to gallons per second.

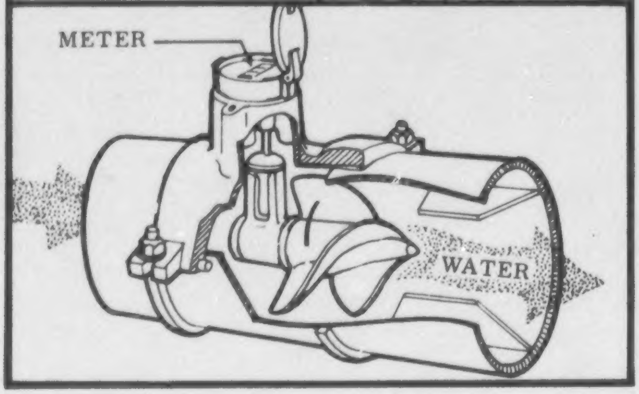
Cu. ft. per second multiplied by gallons per cu. ft. = gallons per second
Example: 1.8 cu. ft. per second multiplied by 7.48 gallons per cu. ft. = 13.46 gallons per second
Sixty seconds = 1 minute; therefore, 13.46 multiplied by 60 seconds = 807 gallons per minute



The Parshall flume equipped with two gages is another way to measure water flow. It is placed in the canal or irrigation ditch. The depth of water is measured at two points and the quantity of flow is determined by using the measurements with a table that is made for that size of flume.



A table is also used for certain types of weir notches. Stakes or gages are placed upstream in open ditches and the depth of water is measured at the bottom of the weir notch on the stake to the top of the water level on the same stake.



There are two major methods used to check the rate of flow in wells. The flow meter is mounted in a tube or pipe, and as the water passes the propeller, the flow rate is recorded on the meter. This is considered one of the most accurate meter methods used to check the flow of water. The flow meter registers gallons per minute and cubic feet of flow. The second method of well flow measurement is done by placing an orifice plate on the well outlet pipe, tapping the outlet pipe and inserting a tube (pipe) connected to a glass tube vertical with the surface and using a ruler (gage) to measure the water as it is forced into the glass tube.

Soil Properties Important To Irrigation

The three major soil properties are: soil texture (size of individual soil particles), soil structure (the way particles are grouped together), and soil depth and layering. These three properties help define the following characteristics of the soil:

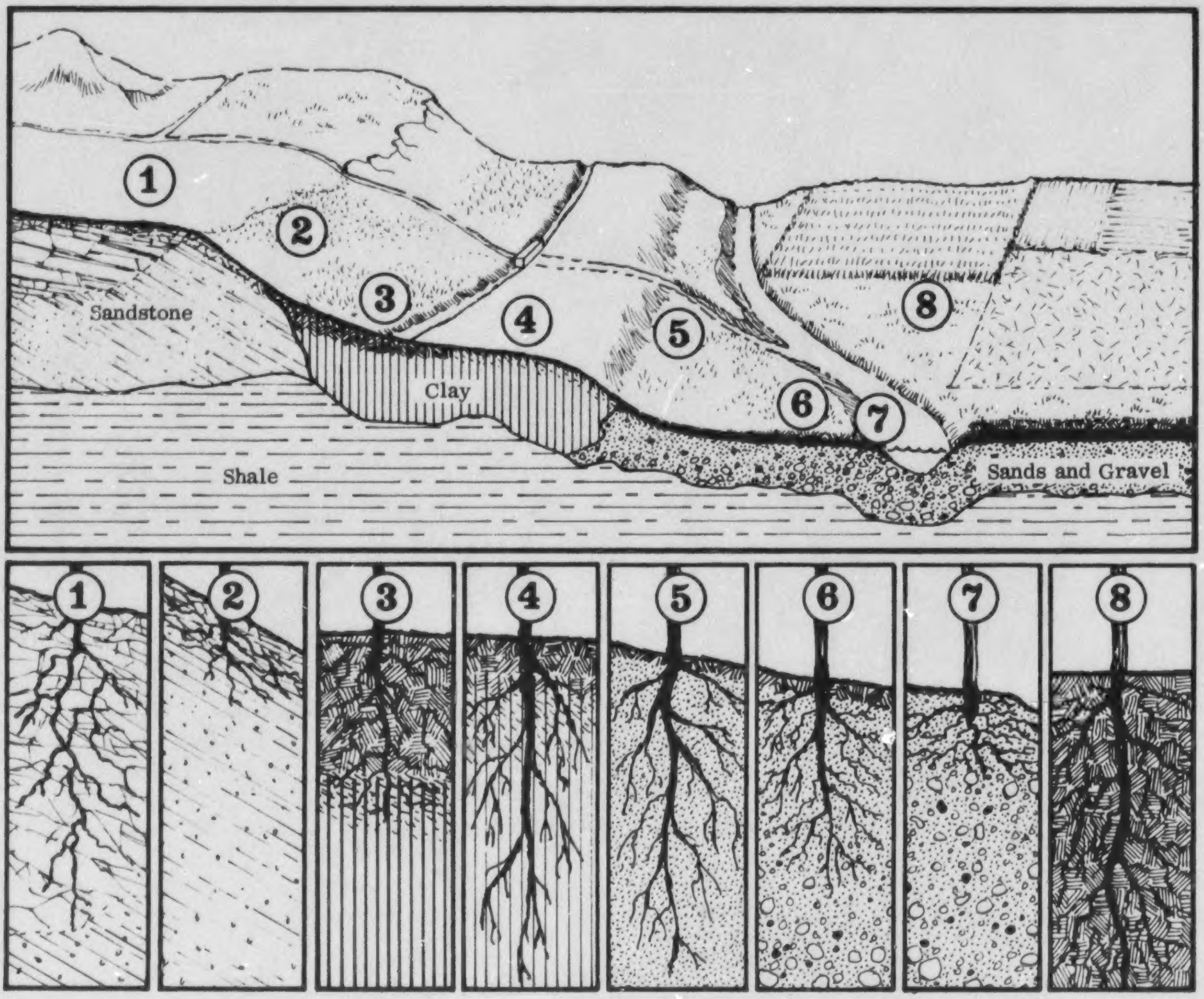
Available Moisture - The soil's capacity to store water for plant use.
Permeability - The rate of movement of water through the soil.
Intake Rate - The rate the water enters the soil.

Soil properties control root penetration of plants. Usually soil characteristics vary with the lay of the land.

The depth and layering of soils will affect root growth and will determine the irrigation practices to use for maximum plant growth without wasting water.

The depth that a root penetrates and its development depend mainly upon soil layering, if adequate moisture is available. Various depths and layering of soils and their effect on root penetration are shown as follows:

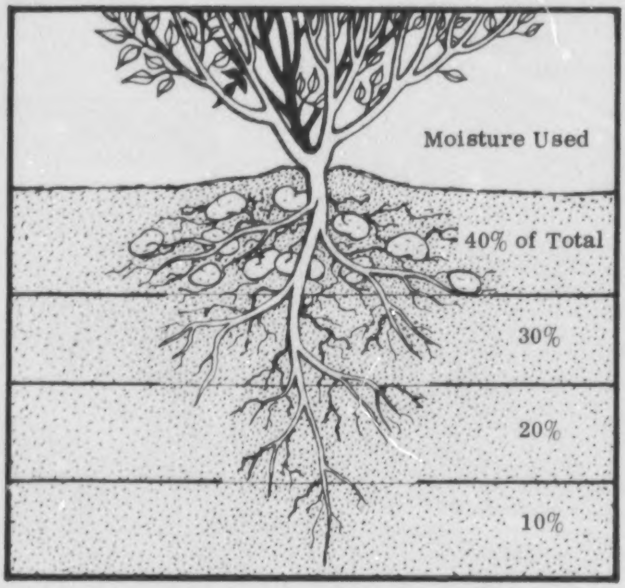
(1) Moderately deep over fractured rock
(2) Shallow over sandstone and rock
(3) Loam surface soil over clay, underlain by dense clay
(4) Deep, uniform clay
(5) Deep, uniform sand
(6) Moderately deep over sand and gravel
(7) Very shallow over sand and gravel
(8) Deep, uniform loam



The soil must be wetted to the depth that the roots will likely penetrate. Listed below are penetration depths of several mature plants:

Irrigated pasture grasses	1.5 feet to 3 feet
Alfalfa	4.0 feet to 8 feet
Corn	4.0 feet to 5 feet
Small grains	3.0 feet to 5 feet
Sugar beets	3.5 feet to 5 feet
Potatoes	2.0 feet to 4 feet
Beans	2.5 feet to 4 feet

Irrigation Practices to Improve Quality and Quantity



It is important that the soil contains adequate moisture throughout the root zone even though the plant may use as much as 40 percent of the available moisture in the top one-fourth of the root zone depth. For example, if a potato root penetrates the soil 4.0 feet, 40 percent of the moisture used by the plant will be located in the first foot of soil. To receive maximum production from the potato plant, the last one-fourth or 25 percent of the root zone depth must be moist. In the last or fourth root zone depth, plants receive about 10 percent of their moisture for growth and reproduction; therefore, this zone is very important even though 90 percent of the moisture furnished to the plant is in the upper three zones.

When To Irrigate - Critical Periods

The periods during which soil moisture is very important are:

All crops	Prior to planting
Potatoes	Blossom to harvest
Melons	Blossom to harvest
Cotton	First bloom through boll-maturing state
Corn	Tasseling through silking
Small Grain	Boot to heading
Pasture	After grazing
Alfalfa	Start of flowering and after cutting
Orchard	Fruit development

Determining when to irrigate by crop appearance includes:

Temporary wilting during the hottest part of the day which indicates the need for water in root crops.
Grain crops wilt during the hottest part of the day if there is a need for water.
Alfalfa changes to a dark green color when there is a lack of moisture.
The need for water in fruit crops is detected by a wilted appearance of the leaves. Fruit growth may be retarded if this leaf observation method is used for determining moisture needs. Continuous soil moisture tests will insure good production, if water use is based upon tests.

Determining when to irrigate by estimating soil includes the following:

Soil moisture content can be either measured by tensiometers, electrical conductance meters, moisture counting (calculating by daily inventory the water remaining in the soil), or the "feel" test.
When using the feel and appearance test, a soil sample is taken by using a shovel, soil auger, or tube. The feel and appearance of a handful of soil that has been squeezed very firmly may be compared with the soil moisture and texture guide (Table I).
If clay loam is estimated to average 50 percent available moisture in a root zone three feet deep, and the soil is estimated to hold 2.0 inches of moisture per foot or a total of 6.0 inches in the root zone at field capacity, then 3.0 inches of water should be added due to 50 percent of the moisture being available.
Depth of water penetration into the soil may be checked a day or two after irrigation; water should have penetrated three feet. If the penetration depth is more or less than three feet, the irrigation schedule should be adjusted to give the proper depth of moisture penetration.

Crop Soil Moisture Guide
Table I

Available Soil Moisture Remaining	Feel or Appearance of Soil			
	Coarse Texture	Moderately Coarse Texture	Medium Texture	Fine & Very Fine Texture
0 to 25 percent	Dry, loose, single-grained, flows through fingers.	Dry, loose, flows through fingers.	Powdery dry, sometimes slightly crusted but easily broken down into powdery condition.	Hard, baked, cracked, sometimes has loose crumbs on surface.
25 to 50 percent	Appears to be dry, will not form a ball with pressure. *	Appears to be dry, will not form a ball. *	Somewhat crumbly but holds together from pressure.	Somewhat pliable, will ball under pressure. *
50 to 75 percent	Appears to be dry, will not form a ball with pressure.	Tends to ball under pressure but seldom holds together.	Forms a ball, somewhat plastic, will sometimes slick slightly with pressure.	Forms a ball, ribbons out between thumb and forefinger.
75 percent to field capacity (100 percent)	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.	Forms a ball is very pliable, slicks readily if high in clay.	Easily ribbons out between fingers, has slick feeling.
At field capacity (100 percent)	Upon squeezing, no free water appears on the soil, but wet outline of ball is left on the hand.	Upon squeezing, no free water appears on the soil, but wet outline of ball is left on the hand.	Upon squeezing, no free water appears on the soil, but wet outline is left on the hand.	Upon squeezing, no free water appears on the soil, but wet outline of ball if left hand.

* Ball is formed by squeezing a handful of soil very firmly.

SUGGESTED STUDENT ACTIVITIES

1. Answer the following questions:

   a. Define the following terms:

      (1) Irrigation -

      (2) One acre foot of water -

      (3) Soil texture -

SEED SELECTION AND METHODS USED IN PLANTING

There is no substitute for seed that will produce both quantity and quality plants, fruit, and/or seed. The seed is like other organisms - it is the product of its parents and its environment, and it is the best known means of propagating plants. It is considered advisable that the crop producer (farmer) use the necessary skills required to make a selection of high-quality seed. Money and time is not saved by purchasing cheap seed. The type of crop harvested depends largely upon the type of seed planted. Large producers of any one crop select seed that will give a maximum return for their investment.

The Major Characteristics of Good Seed

Good seed is viable (strong germination percentage), and it will produce fast growing seedlings. It is of more value to the producer because the possibility of getting a good stand is greater. Good seed will stay viable from the time they are harvested until they are planted the following season.

Good seed is considered pure. It is free of primary noxious-weed seed and it is practically free of all other seed and contains a minimum of inert material.

Good seed is well developed. The large seed have a tendency to produce their own type from the parent plant; therefore, larger yields are realized than from smaller seed. Large, plump, and well-developed seed contain more plant food to give the young plant a good start.

Good seed is considered free of disease. Diseases such as potato scab, grain smuts, and corn root rot are more expensive to destroy in the seed than buying disease-free seed. The great loss in using diseased seed is not found in the cost of the seed, but it is the enormous loss in the crop produced from the diseased seed.

Good seed will produce a maximum in quantity and quality, because it is adaptable to the climate and soil of the locality. It may be a variety that shows certain resistance to insects and diseases and has plant vigor that is lacking in other seed varieties. Good seed from varieties that have been tested locally should be selected.

Good seed is uniform in size and development. If inferior seed are mixed with good seed, large plants from the good seed will have a tendency to crowd out the inferior seed and may even mature at an earlier date. Large and small seed from the same plant usually carry the same hereditary characteristics, but the larger seed furnish a better start for the young plant due to more plant food being stored.

Good seed may be identified by the name it carries each year. The better known seed companies either grow or buy from reliable producers, and they label the varieties correctly each year.

Conditions That May Exist When Good Seed Are Not Selected

Seed has low germination percentage
Seed contains large amounts of inert matter (chaff, broken seed, and dirt particles)
Seed lacks resistance to disease
Seed lacks resistance to insects
Seed lacks adaptability to certain climatic and growing conditions
Seed contains large amounts of other crop seed
Seed is infested with weed seed
Seed fails to remain viable from harvest to planting time

Some Types of Weeds to Avoid When Selecting Field Crop Seed

Primary noxious-weed seed include:

Bindweed
Wild onion

Nutgrass
Blueweed
Johnson grass
Russian Knapgrass
Quackgrass
Canada thistle
Bermudagrass

Secondary noxious-weed seed include:

Dodder
Cocklebur
Goatgrass
Wild radish
Red rice
Wild carrot
Chess
Persian ryegrass
Dock and sorrel
Wild mustard
Wild oats
Buckhorn plantain
Puncture vine
Morning glory

Some Methods Used to Secure Good Seed

Home grown seed

Use certified seed for the first planting.
Select a clean ground and control weeds and insects throughout the production period.
Prevent seed from mixing with other seed at the gin and in the combine.
Store the dry seed in a dry, cool place.
Treat the seed for diseases and insects during storage and at planting time.
Test the seed for germination percentage before planting.

The use of certified seed

Purchasing certified seed from reliable dealers is a sure way of selecting quality seed for crop production. At least there is a better chance of selecting seed adaptable to the community and almost free of diseases and weeds. State seed laws have been established to protect both the buyer and the seed dealer. State seed laws conform to the Federal seed laws.

A seed label on the seed container gives terms required by the state. There are four classes of certified seed used in the certified seed program in Texas. The classes are as follows:

Breeder Seed (White tag) - Breeder seed is used by the breeder to maintain the strain or variety. It is never for sale or used by the general public.

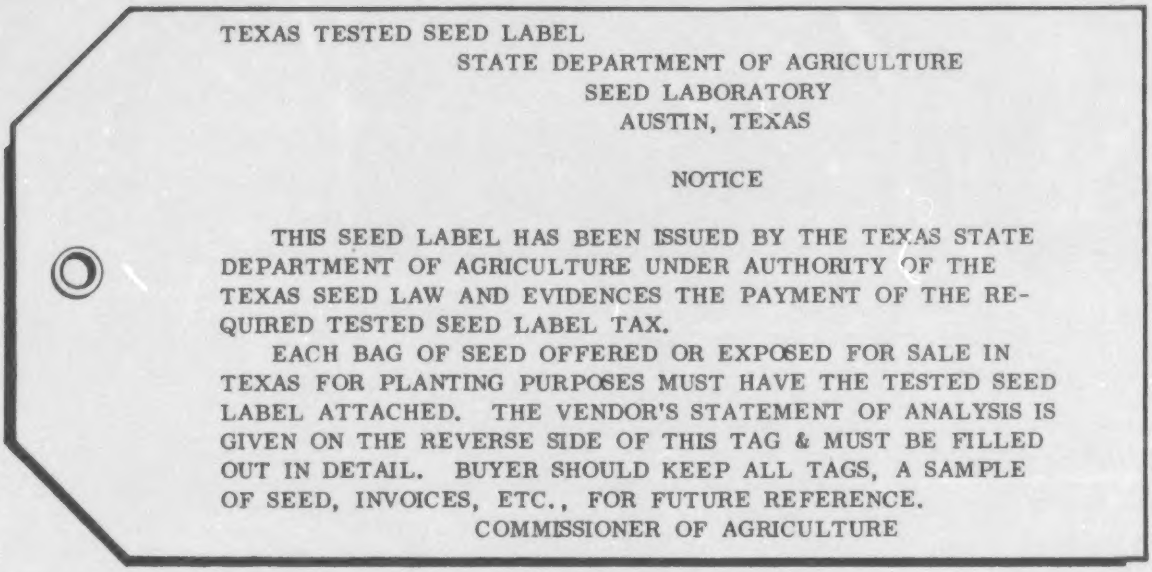
Foundation Seed (White tag) - Foundation seed shall be seed stocks so handled as to most nearly maintain specific genetic identity and purity and that may be distributed by an experiment station. It can be produced on a farm but under the supervision of an agronomist. Foundation seed shall be the source of registered seed.

Registered Seed (Purple tag) - Registered seed shall be so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. It shall be a class of seed suitable for the production of certified seed.

Certified Seed (Blue tag) - Blue tag certified seed shall be the progeny of Foundation, Registered, or Certified seed that is so handled as to maintain satisfactory genetic identity and purity and that has been approved and certified by the certifying agency. Green tag certified seed may be seed of the first year's increase from the blue tag or seed that fail to meet the registered requirements.

Information on the Seed Tag

Texas Seed Label - Front Side


TEXAS TESTED SEED LABEL
STATE DEPARTMENT OF AGRICULTURE
SEED LABORATORY
AUSTIN, TEXAS

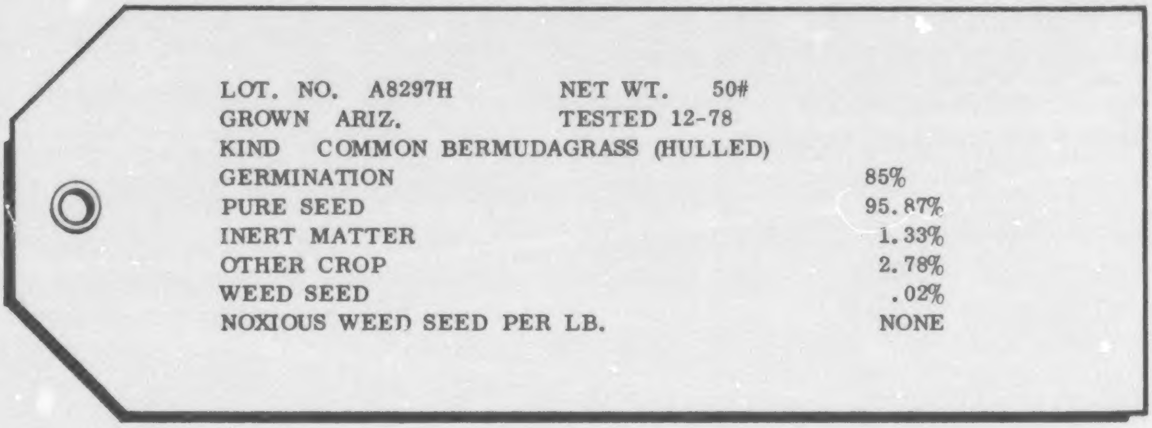
NOTICE

THIS SEED LABEL HAS BEEN ISSUED BY THE TEXAS STATE DEPARTMENT OF AGRICULTURE UNDER AUTHORITY OF THE TEXAS SEED LAW AND EVIDENCES THE PAYMENT OF THE REQUIRED TESTED SEED LABEL TAX.

EACH BAG OF SEED OFFERED OR EXPOSED FOR SALE IN TEXAS FOR PLANTING PURPOSES MUST HAVE THE TESTED SEED LABEL ATTACHED. THE VENDOR'S STATEMENT OF ANALYSIS IS GIVEN ON THE REVERSE SIDE OF THIS TAG & MUST BE FILLED OUT IN DETAIL. BUYER SHOULD KEEP ALL TAGS, A SAMPLE OF SEED, INVOICES, ETC., FOR FUTURE REFERENCE.

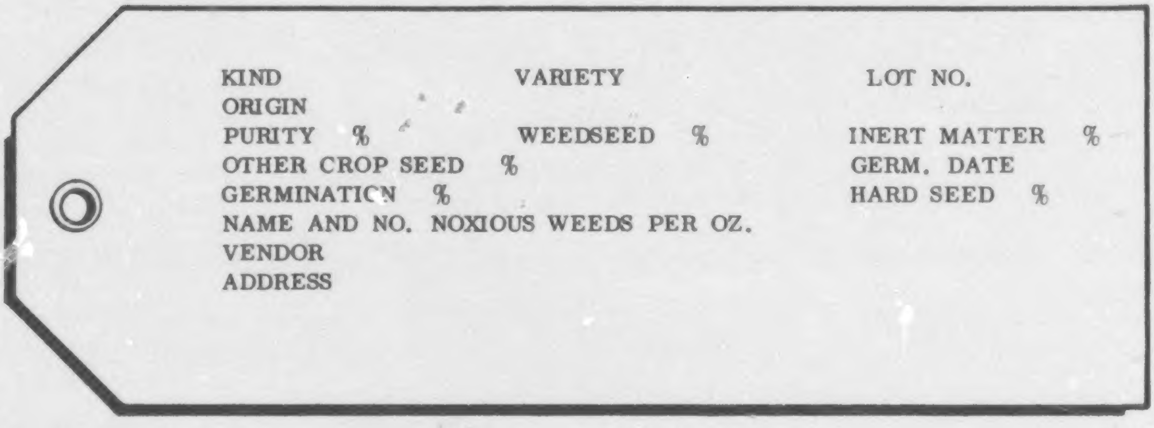
COMMISSIONER OF AGRICULTURE

Texas Seed Label - Back Side


LOT. NO. A8297H NET WT. 50#
GROWN ARIZ. TESTED 12-78
KIND COMMON BERMUDAGRASS (HULLED)

GERMINATION	85%
PURE SEED	95.87%
INERT MATTER	1.33%
OTHER CROP	2.78%
WEED SEED	.02%
NOXIOUS WEED SEED PER LB.	NONE

Out-of-State Seed Label - Back Side


KIND VARIETY LOT NO.
ORIGIN
PURITY % WEEDSEED % INERT MATTER %
OTHER CROP SEED % GERM. DATE
GERMINATION % HARD SEED %
NAME AND NO. NOXIOUS WEEDS PER OZ.
VENDOR
ADDRESS

Seed Terms

Variety - Subdivision of a species such as mustang oats.

Lot Number - Limited to 5000 bushels of seed. Seed of the same specie and variety grown in different fields but mixed to form a "lot".

Pure Seed - The percentage of seed that will produce plants true to variety and type.

Inert Matter - The percentage by weight of chaff, broken seed, stems, and soil particles.

Weed Seed - The percentage by weight of seed that are considered weeds.

Other Agricultural Crop Seed - The percentage by weight of seed not of the specified variety.

Germination - The percentage of seed that will produce normal plants under normal conditions.

Hard Seed - The percentage of seed which remain hard and sound at the end of a germination period.

Date of Test - The date the laboratory test was made on the seed.

Pure Live Seed - The amount of seed that when planted will produce plants.

Selecting Seed Samples for Testing

The bulk and bag procedures are as follows:

> Bulk seed should be sampled by inserting a long probe or thrusting the hand into the bulk, as circumstances require, in at least seven uniformly distributed parts of the quantity being sampled. At least as many trierfuls or handfuls should be taken as the minimum which would be required for the same quantity of seed in bags of a size commonly used for such seed.
>
> For lots of six bags or less, each bag should be sampled. A total of at least five trierfuls should be taken.
>
> For lots of more than six bags, five bags plus at least ten percent of the number of bags in the lot should be sampled. Some persons prefer to sample every fifth bag but not less than five bags when the quantity is more than five bags. In any case, time should be given to drawing a representative sample from the lot.

Information given on the seed sample should include:

Name and address of sender
Kind - Variety (if known)
Lot number or other stock identification
Year grown, month of harvest, and where grown
Test desired (purity only, germination only, or both)
Seed treatment (name of the seed treatment substance and the rate of application)

The following information and addresses are used when having seed samples tested:

> Samples should be mailed in cloth bags or strong cardboard containers. Paper bags and ice cream cartons are very unsatisfactory, usually bursting in transit.
>
> Depending on your location, samples may be addressed to one of the following Texas Department of Agriculture Seed Laboratories:

Texas Department of Agriculture
Seed Laboratory
105 West Sixteenth Street
Austin, Texas 78701

Texas Department of Agriculture
Seed Laboratory
1924 34th Street
Lubbock, Texas 79411

Texas Department of Agriculture
Seed Laboratory
East College Street
Post Office Box 4625
Stephen F. Austin Station
Nacogdoches, Texas 75962

Determining The Value of Pure Live Seed

Even though high test and clean seed cost more, it is usually the best buy. An example is listed below:

Using the prices and labels from two different lots of Common Bermudagrass (Hulled) seed, the better seed can be selected by the number of pounds of Pure Live Seed that are in each lot and the cost per pound of each lot. For example, which of the following lots should be selected:

	Lot I		Lot II
Germination	85.00%	Germination	80.00%
Inert Matter	1.33%	Inert Matter	2.45%
Weed Seed	.02%	Weed Seed	.02%
Other Crop Seed	2.78%	Other Crop Seed	3.78%

To determine the purity content:

	Lot I		Lot II
Inert Matter	1.33%	Inert Matter	2.45%
Weed Seed	.02%	Weed Seed	.02%
Other Crop Seed	2.78%	Other Crop Seed	3.78%
Non Purities	4.13%	Non Purities	6.25%

Lot I	Lot II
100.00%	100.00%
- 4.13%	- 6.25%
95.87% Pure Seed	93.75% Pure Seed

Lot I is $65.00 per hundred.

Lot II is $63.00 per hundred.

The following formula can be used to determine the value of the different lots.

$$\frac{\text{Price per unit}}{\text{Purity\% x germination\%}} = \begin{array}{c}\text{price paid per}\\ \text{hundred pounds of pure live seed}\end{array}$$

Lot I

$$\frac{\text{Cost per hundred } \$65.00}{\text{Purity } 95.87\% \text{ x germination } 85\%} = \$80.24 \text{ per hundred pounds for live seed}$$

Lot II

$$\frac{\text{Cost per hundred } \$63.00}{\text{Purity } 93.75\% \text{ x germination } 80\%} = \$84.00 \text{ per hundred pounds for live seed}$$

The seed cost of Lot II is more expensive for pure seed, even though the price per hundred weight is slightly lower than Lot I. The seed label is the "key" to the best seed buy; therefore, it should be studied before making the purchase.

History of the Different Types of Planting Equipment

The planter is recognized as one of the greatest United States inventions. The grain drill was patented in 1799, the first cotton planter was patented in 1825, and the corn planter was patented in 1839. By 1880, over 50 percent of the wheat crop in the United States was sown by grain drills. The first check row planter was put into use in 1875.

Planting seed has always been looked upon as a special agriculture activity. The early settlers in 1609 found the American Indians using special practices in planting corn by hand. Roman history tells us that the Romans used as much special care in planting their crops as they did in training their armies. Some of the early planting practices included plowing the soil with a wood plow and dropping seed in the plowed soil, by making seed holes with a stick, by dropping seed by hand in the plowed furrow, or transplanting plants taken from a crude seedbed.

Purposes and Types of Planters and Drills

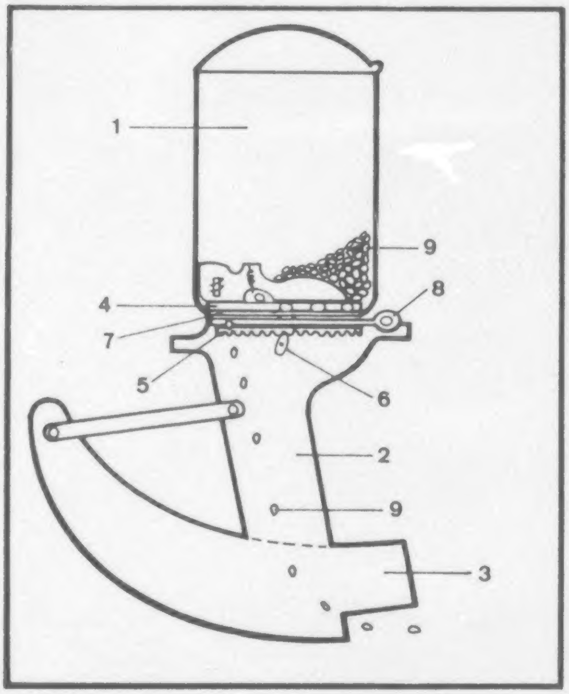
Row-crop planters are used to plant the major row crops such as cotton, sorghum, corn, peas, beans, vegetables, and potatoes. Some of the functions of row-crop planters are; plant more than one type of seed, seed accurately planted at a moderate to fast speed, sow seed at a uniform depth, plant at different row spacings, and apply fertilizer, insecticides, and herbicides. The most common sizes of these planters are two, four, six, and eight row. A six-row planter will plant 30 to 35 percent more acreage than a four-row planter if both travel at the same rate of speed. Planter size is usually determined by the amount of acreage to be planted in any one season.

Three classes of trailing type and tractor mounted planters are:

Drill Planters - The drill planter places the seed evenly in seedbeds. Seed fall from the seed plate to the ground. Spacing of seed is regulated by the relation of the seed plate speed and the ground speed. The major parts of this type of planter are a hopper, metering device, seed tube, furrow opener, and a covering device. Drill planters may operate with fertilizer plant pest attachments. They are not equipped with parts needed for checking.

Hill-Drop Planters - This planter is constructed to collect seed and drop them in hills at regular intervals in the row. Some hill-drop planters can be adjusted to drill, and they can be used to check plant if equipment with the check-row attachment. The parts are: seed hopper, metering device, valve system to collect seed, furrow opener, and a covering device.

Check-Row Planters - This planter is constructed with valves and checkheads to collect seed and drop them at the same place in each row so that the plants may be cultivated both with the original rows and across the rows. The valves may be locked open as in the hill-drop planter so that the seed may be drilled along the row.



The main parts of a planter hopper, attachments, and seed are: (1) hopper, (2) shank, (3) runner opener, (4) seed plate, (5) ring gear, (6) shaft, (7) filler plate, (8) false bottom plate, (9) seed.

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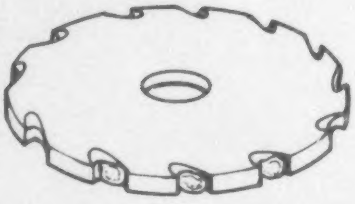
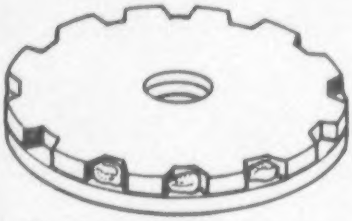
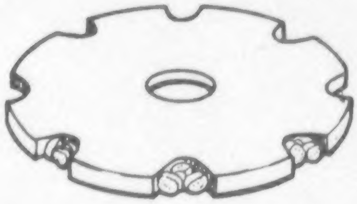
The heart of the field crop planter is the seed plate. Each plate is made for a certain type and size of seed. Plate cells may be round, oblong, or oval. For example, there are three different plates used for planting corn, but there are several cell sizes due to the size of grain. These plates include:



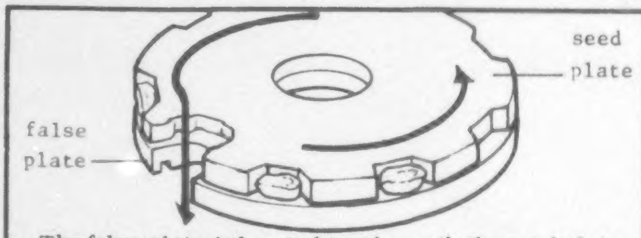
The edge-drop plate carries kernels of corn on the edge around the outer part of the plate.



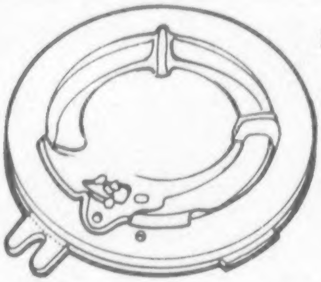
The flat-drop plate carries the kernels in a flat position around the outer edge of the plate.



The full-hill plate carries three or four kernels per cell in the edge of the plate.

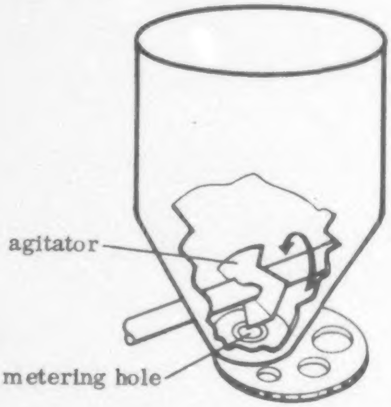


The false plate is located just beneath the seed plate. In fact, the seed ride on this plate as they are carried to the opening.



Hoppers of this type are also equipped with a cutoff, drive, and floor plate.

There are many different types of seed metering devices found on different types of planters. The finger-pickup metering system (12 spring loaded fingers) was developed to eliminate the changing of plates every time seed size changed. Another system includes three different air metering devices. One type has a pressurized metering drum, another a pressurized metering disk, and a third a vacuum metering disk. When using these systems the openings in the wheel or drum should be matched with the seed, and the pressure differential should be matched with the weight of the seed.



Crop vegetables are usually planted by using a type of adjustable-hole metering system. As the agitator moves, the seed are distributed evenly over the opening. A small amount of seed fall through the opening into the tube. The type of seed determines the size of metering hole to use.

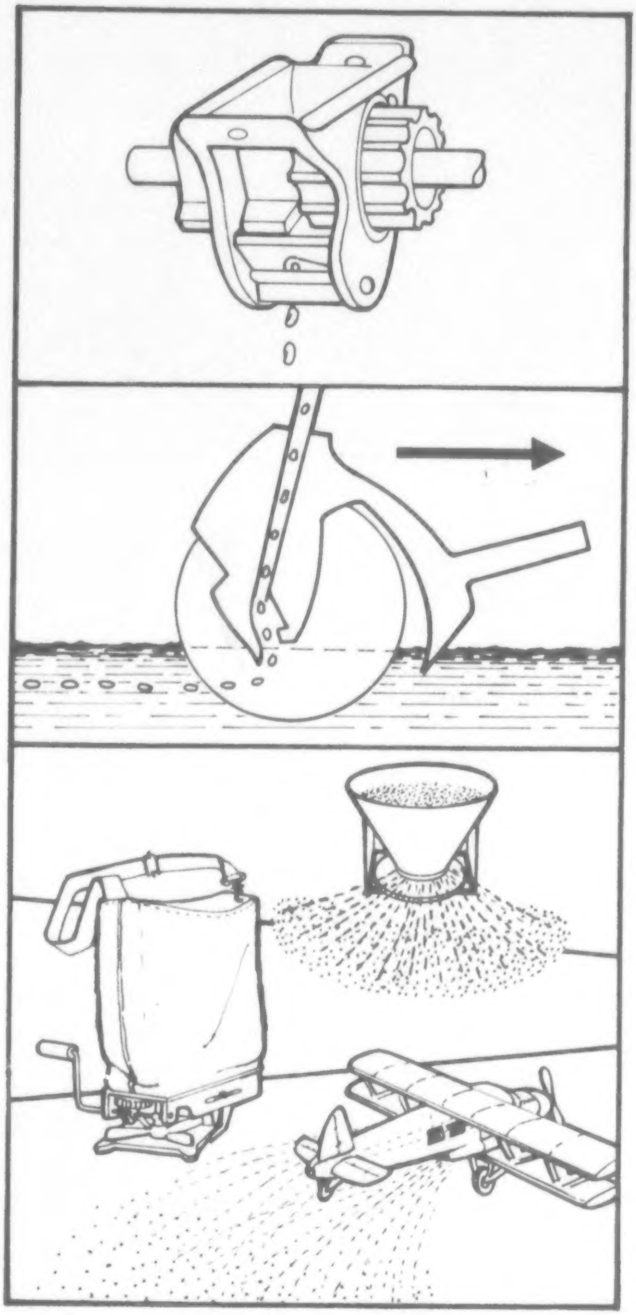
Furrow Openers and Coverers

Planters are equipped with certain types of furrow openers. The variable-depth opener is used for cotton; the curved runner opener for cotton and corn; the single disk opener for stony and trashy soil; the curved double disk opener for trashy soil; and the colter double disk opener for soil that is not too trashy.

Furrow coverers are of many types. The open center press wheel is most commonly used. Other types of coverers are: rubber-tired press wheels, zero-pressure rubber tires, disk coverers, blade coverers, shovels, and knife coverers.

Planting With Grain Drills

There are two major types of grain drills. They are the endwheel drill which is operated by wheels supporting the drill unit and driving it and the press-wheel drill that has wheels mounted on the rear of the drill. These wheels also support the drill, drive the mechanism, and press the drilled in seed. Drills plant the seed in narrow rows at the same depth. A 12-6 drill has twelve row openers six inches apart. The drill, like the planter, may have fertilizer hoppers mounted on the equipment.



Many drills are equipped with double run feeding devices located in the hopper. The coarse ribbed side of the device is used to sow large grain such as peas, beans, corn, and similar large seed. The fine ribbed side is used to sow oats, wheat, barley, rye, rice, and other small grain. By using wire reducers alfalfa and clover seed are sown.

Double disk openers are usually considered standard equipment on this type of drill. Seed are covered and packed by drag chains or they may be packed by special wheels.

Other Types of Planting Equipment

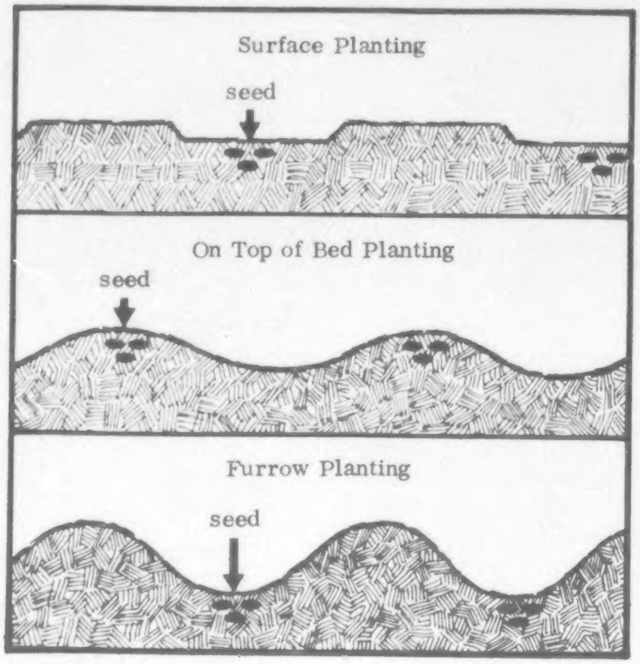
Spinner Type Seeder - One of the most popular broadcast seeders is the spinner type. It is of two types - the mounted and pull. Both are usually driven by the tractor PTO. Seed are distributed evenly by falling on a fast turning ribbed wheel.

Knapsack Seeder - This seeder is usually carried by using shoulder straps. Seed are thrown from the ribs on the wheel as it is rotated from crank gears as the crank is turned by hand.

Airplane - The airplane is used to spread seed over a wide area, whereas the knapsack is used for a very small area. This type of equipment is used to broadcast clovers, rice, and grass seed.

Methods of Planting

The methods of planting depend upon the following conditions: rainfall, soil drainage, soil moisture-holding capacity, soil temperature, fertilizer use, and weed control practices. Due to these different conditions, seed are sown on three different levels.



This method may be considered flat planting. It is used to conserve soil moisture in semi-arid, regions. The final preparation of land for flat planting is done by use of a disk harrow. Refer to IV-E-2, Land Preparation.

Lister plows are used to make beds for planting seed in areas where it is better to elevate the seed on beds due to soil drainage problems or other problems that may affect seed planted flat in the bottom of furrows.

Bottom-of-furrow planting is usually practiced in semi-arid regions where there is a need to protect the small plant against a lack of moisture and strong wind.

Blackland planting is usually done on beds after the bed is disked or cultivated to remove weeds. In blackland areas the land is bedded in time for it to settle before planting, which is several weeks or even months before planting season.

Rate and Space in Planting of Crop Seed

The quantity of seed and the spacing of crop plants per acre is to obtain the maximum yield and maintain the quality of the product. The amount of seed planted per acre varies according to whether or not the land is irrigated or dry land, fertile or infertile soil, short or long season crops, and use of the crops.

The rate, spacing, and method of seeding a field crop does not happen by chance. Each of the practices have been approved for each locality by years of experience.

Crop	Rate of Planting Per Acre	Seeding Space	Method of Seeding
Alfalfa	15 to 25 lbs.	Drill or Broadcast	Drill, Seeder, Hand
Bermudagrass	5 lbs.	Broadcast	Seeder, Hand
Coastal Bermudagrass	12 to 20 bu. sprigs	4 to 10 inches	Sprigger, Hand
Corn	6 to 12 lbs.	10 to 13 inches	Rows - 34" to 42"
Cotton	1 bu. (32 lbs.)	3 plants per foot	Rows - 36" to 48"
Cowpeas	1/2 to 3/4 bu. (bu. - 60 lbs.)	2 to 4 inches	Rows - 18" to 36"
Oats	2 to 3 bu. (bu. - 32 lbs.)	Drill or Broadcast	Drill or Broadcast
Peanuts	25 to 50 lbs.	4 to 6 inches	Rows - 28" to 30"
Redtop	3 to 5 lbs.	Broadcast	Drill or Broadcast
Grain Sorghum	7 to 8 lbs.	4 to 6 inches	Rows - 35" to 42"
Sweet Sorghum	8 to 10 lbs.	4 to 6 inches	Rows - 36" to 42"

Crop	Rate of Planting Per Acre	Seeding Space	Method of Seeding
Soybeans	25 to 35 lbs. (60 lbs. - 1 bu.)	Broadcast or Rows	Broadcast or Rows
Sudangrass	20 to 30 lbs.	Drill, Seeder, Hand	Drill or Broadcast
Wheat	60 to 120 lbs. (60 lbs. - 1 bu.)	Drill	Drill
Barley	72 to 96 lbs. (48 lbs. - 1 bu.)	Drill	Drill
Rice	90 to 100 lbs.	Drill	Drill

Depth to Plant and Germination Period

Soil condition is one of the major factors in determining the depth to plant. The factors that determine depth to plant are:

Soil Texture - Seed can be planted deeper in sandy soil than clay soil.

Soil Temperature - Seed can be planted deeper in warm soil than cold soil.

Soil Moisture - Seed are usually planted deeper in dry soil than wet soil.

Plant Structure - Peas can be planted deeper than beans because their cotyledons remain below the soil. Bean cotyledons must emerge from the soil. Large seed will emerge from a greater depth than small seed.

Germination may be considered a heredity characteristic, but temperature, moisture, and oxygen also affect the length of time it takes different seed to germinate. Crops are usually planted shallow in clay soils and deep in sandy soils.

Crop	Average Planting Depth - Inches	Days Required for Germination
Alfalfa	1/4 to 3/4	4- 7
Bermudagrass	1/4 to 1/2	7-21
Corn	1 to 3	4- 7
Cotton	1 to 3	4-12
Cowpeas	1 to 3	6- 8
Oats	1 to 2	5-10
Peanuts	1 to 2	6-12
Redtop	3/4 to 1	8-10
Grain Sorghum	1 to 2	8-10
Sweet Sorghum	1 to 2	8-10
Soybeans	1 to 2	5- 8
Sudangrass	3/4 to 1-1/2	8-10
Wheat	1 to 2	3- 7
Barley	1 to 2	3- 7
Rice	On surface or 1" deep	12-14

Usual Planting and Harvesting Dates by Crops and Principal Producing Areas

The Texas Crops Reporting District map may be used to locate areas and counties where principal crops are grown. Refer to IV-A-2.

Crop	Usual Planting Dates	Usual Harvesting Dates		Principal Producing Areas & Counties
		Begins	Ends	
Barley	Sept. 10-Nov. 25	May 15	June 30	1n, 2n, 2s, 4
Broomcorn	Mar. 10-Apr. 25	June 25	July 25	Bee, Medina, Karnes, Live Oak, LaSalle
Corn, Grain	Mar. 5-May 10	Aug. 5	Oct. 20	4, 5n, 8n, 9
Silage	Mar. 5-May 10	June 10	Aug. 20	1n, 4, 8n
Forage	Mar. 5-May 10	June 20	Aug. 5	4, 8n, 9
Cotton	Mar. 10-June 15	July 25	Jan. 10	Statewide
Cowpeas for Peas	Mar. 15-June 20	May 25	Aug. 20	1s, 3, 4, 5n, 5s, 10n
Flaxseed	Nov. 1-Dec. 20	May 1	June 10	8n, 8s, 10n
Hay, Alfalfa,		May 1	Sept. 30	1n, 2n, 4, 6, 9
Wild		June 10	Sept. 25	Statewide
Oats	Sept. 10-Nov. 25	May 10	June 25	2s, 3, 4, 7, 8n
Peanuts for Nuts	Apr. 1-Aug. 1	July 15	Dec. 15	3, 4, 8n, 10n
Popcorn	Apr. 1-May 1	July 20	Sept. 1	Lamar, Fannin, Guadalupe
Rice	Mar. 25-June 1	July 15	Nov. 15	9
Rye	Sept. 1-Nov. 20	May 10	June 25	1n, 1s, 2n, 2s
Sorghum, Grain	Mar. 10-July 1	July 1	Dec. 1	Statewide
Silage	Mar. 10-July 1	June 10	Aug. 20	Statewide
Soybeans	June 5-July 10	Oct. 20	Dec. 25	1n, 1s, 5n
Wheat, Winter	Sept. 1-Nov. 20	May 25	July 5	1n, 2n, 2s, 4
SEED CROPS:				
Alfalfa		Aug. 1	Sept. 30	2n, 6
Sweetclover		July 1	Aug. 10	4, 5n, 8n
Sudangrass		Aug. 25	Nov. 25	1n, 1s
Hairy Vetch		May 25	July 5	4, 5n

SUGGESTED STUDENT ACTIVITIES

1. Place a T beside the True statement and an F beside the False statement.

______ a. The use of seed is usually considered the best means of propagating plants.
______ b. Large and small seed from the same plant usually carry the same hereditary characteristics.
______ c. There are eight classes of certified seed used in the certified seed program in Texas.
______ d. Furrow planting is practiced in areas where the rainfall is heavy during planting season.
______ e. Blackland planting is usually done on the flat surface.
______ f. Dry land and irrigated planting do not affect the amount of seed planted.
______ g. Seed can be planted deeper in sandy soils than clay soils.
______ h. Seed is usually planted deeper in dry soil than wet soils.
______ i. The knapsack seeder has a spinner type attachment.
______ j. Many grain drills are equipped with both large and small seed metering units.

2. Completion

a. As the ______________ moves in the hopper, the seed are distributed evenly over the metering hole.
b. The ______________ plate carries corn kernels in a flat position around the outer edge of the plate.
c. A field planted with a ______________ planter can be cultivated both ways (with the original rows and acros the rows).
d. A six-row planter will plant ______ to ______ percent more acreage than a four-row planter if both travel at the same rate of speed.
e. Drills plant the seed in ______________ rows at the same depth.
f. Good seed is ______________ in size and development.
g. Good seed is ______________ (strong germination percentage), and will produce fast growing seedlings.
h. Poor seed contain large amounts of ______________ ______________ (chaff, broken seed, and dirt particles).
i. Use ______________ seed for the first planting.
j. ______________ seed is used by the plant breeder to maintain the strain or variety.

3. List the following:

a. Conditions that may exist when good seed are not selected:

(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)

b. Five primary and five secondary noxious weed seed:

(1)	(1)
(2)	(2)
(3)	(3)
(4)	(4)
(5)	(5)

c. Information found on the back side of a Texas seed label:

d. Information on the seed sample should include the following:

e. Dates the following equipment was patented:

(1) Grain drill -
(2) Cotton planter -
(3) Check-row planter -
(4) Corn planter -

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